MINSTREL ATE

PRICE: $10.00

Model SNR 488-4

Serial No. . . . . .

INSTRUCTION MANUAL

KEPCO®

POWER SUPPLIES

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SECTION I–INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This manual contains a general description, as well as instructions for the installation, operation and calibration of the KEPCO SN 488 PROGRAMMING SYSTEM, manufactured by KEPCO INC., Flushing, N.Y. U.S.A. The KEPCO SN 488 PROGRAMMING SYSTEM consists of the following components:

1) MODEL SNR 488-4, RACK HOUSING WITH INTERFACE
2) MODEL SNR488-8, RACK HOUSING WITH INTERFACE
3) MODEL SN 488-B/SN 488-D, PLUG-IN PROGRAMMING CARDS
4) MODEL SN 488-K, KEYBOARD
5) MODEL SNC 488-1,-2,-4, BUS INTERCONNECTING CABLES, 1,2 and 4 meters long
6) MODEL SNP 488-1,-2,-4, KEYBOARD CABLES, 1,2 and 4 meters long

1-3 This manual provides complete documentation (Parts Lists, Component Locations, Schematic Diagrams) for the Model SNR 488-4 and SNR 488-8 RACK HOUSING, while all other systems components are, although included in the description here, fully documented within their own Instruction Manuals.

1-4 INTRODUCTION

1-5 The KEPCO SN 488 PROGRAMMING SYSTEM is designed to interface Kepco's programmable power supplies with the GENERAL PURPOSE INTERFACE BUS (GPIB), per IEEE STD. 488-1975. A typical Kepco SN 488 PROGRAMMING SYSTEM is shown in the form of a block diagram in FIG. 1-1. The system as shown, consists of the Model SNR 488-4 Rack Housing with interface card, four (4) plug-in Model SN 488-B or SN 488-D Programming Cards, a Model SN 488-K Keyboard with Model SNP 488 Cable, the bus connecting cable Model SNC 488 plus the programmable Kepco power supplies. Since each Model SN 488-B or SN 488-D Programming Card has two independent control channels, the system shown in FIG. 1-1 can program four (4) power supplies , providing independent control of each supply's voltage and current channel for example.

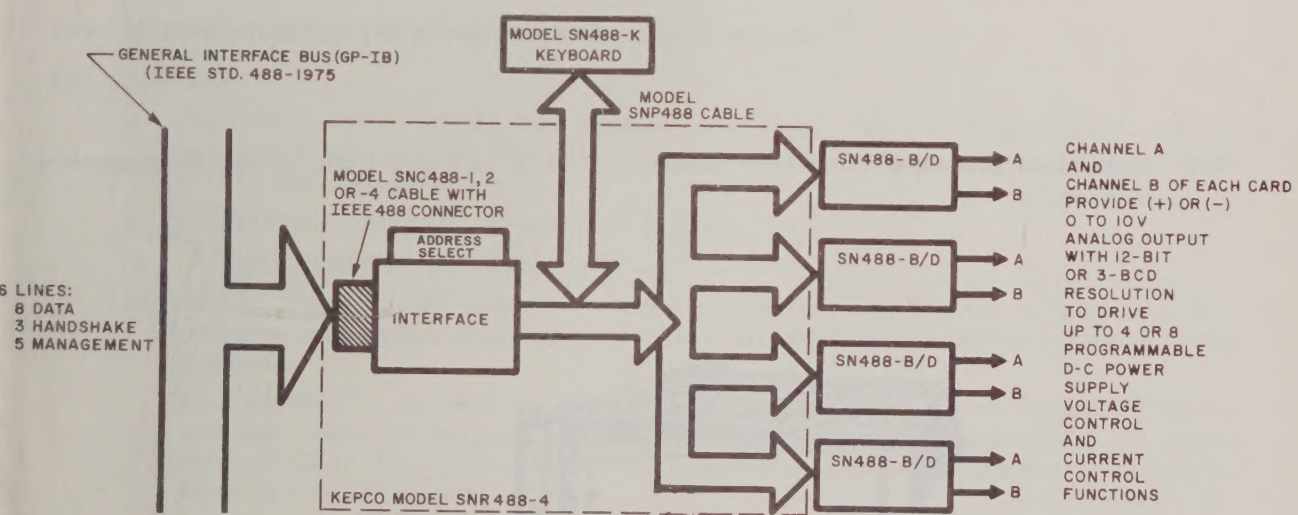


FIG. 1-1 BLOCK-DIAGRAM, KEPCO 488 PROGRAMMING SYSTEM (EXAMPLE)

1-6 While a minimum SN 488 system, consisting of a Model SNR 488-4 Rack Housing and one Model SN 488-B or SN 488-D Programming Card provides two (2) independent outputs, the maximum capacity is provided with Model SNR 488-8 Rack Housing and eight (8) Model SN 488-B or SN 488-D Progamming Cards, providing sixteen (16) independent outputs. The Kepco SNR 488 system is thereby capable of programming multi-power supply installations via a single standard bus connector.

1-7 By means of the Kepco SN 488 Programming Sytem, and " controller" or " talker " on the GPIB bus can communicate with any system power supply. The SN 488 implements the LISTENER (LI) and the ACCEPTOR HANDSHAKE (AHI) functions per GPIB protocol.

1-8 GENERAL DESCRIPTION OF THE KEPCO 488 SYSTEM

1-9 **Kepco Model SNR 488-4,** with built-in interface card, is a 19" rack housing with slots for four (4) programming cards and with room for either two (2) "quarter rack" or one (1) "half-rack" Kepco power supply (see FIG. 1-2).

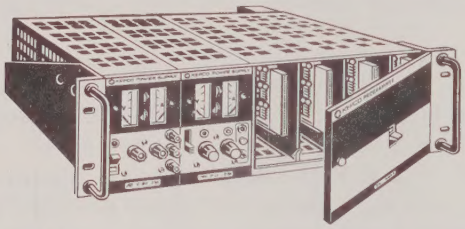


FIG. 1-2 KEPCO MODEL SN 488-4 RACK HOUSING.

1-10 **Kepco Model SNR 488-8** with built-in interface card, is a 19" rack housing slots for eight (8) programming cards (see FIG. 1-3).

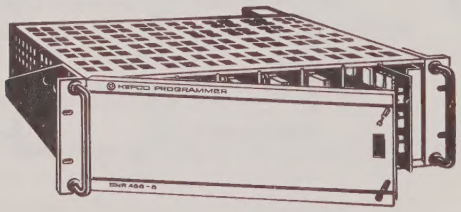


FIG. 1-3 KEPCO MODEL SNR 488-8 RACK HOUSING.

1-11 ACCESSORIESS SUPPLIED

a) Each SNR rack housing is provided with a removable a-c power cord, Kepco P/N 118-0552.

b) Each analog output connector, provided on the SNR housings is provided with a mating connector, Kepco P/N 143-0293.

1-12 ACCESSORIES OPTIONAL

a) **Kepco Model SN 488-B and SN 488-D** are the programming plug-in cards for use in the rack housings described above. Each card provides ***two channels*** of optically isolated, digital to analog conversion. The Model SN 488-B is binary coded with 12-bit resolution. The Model SN 488-D has BCD coding with 3-decade resolution.

A Model SN 488-B or SN 488-D, mounted in either the Model SNR 488-4 or SNR 488-8 and connected to the GPIB and to a suitable Kepco power supply or other analog programmable device, forms a complete digital programming system. This programming system may also be manually controlled by means of the Kepco Model SN 488-K Keyboard, described in PAR. 1-12 b "Accessories, Optional".

Both channels of the Models SN 488-B and SN 488-D may be programmed for ***magnitude, range and polarity.***

b) **Kepco Model SN 488-K Keyboard**, hand-held keyboard capable of addressing the internal bus in the Kepco Model SNR 488-4 or SNR 488-8. The keyboard is intended primarily for off-line testing and calibrating the Kepco 488 System.

c) **Kepco Models SNC 488-1, -2, -4 Bus Interconnecting Cables** with respective lengths of 1, 2, and 4 meters, for connecting SNR rack housing to the IEEE 488 or GPIB bus.

d) **Kepco Models SNP 488-1, -2, -4, Interconnecting Cables** with respective lengths of 1, 2 and 4 meters for connecting the Model SN 488-K Keyboard to the SNR rack housings and thereby to the Kepco internal bus.

1-13 SPECIFICATIONS OF THE KEPCO 488 PROGRAMMING SYSTEM (1)

1-14 GENERAL

a) A-C POWER INPUT (MODEL SNR 488-4 and SNR 488-8): 105 to 125V a-c or 210 to 250V a-c (selectable by built-in switch), 50 to 440 Hz, single phase, approximately 6VA with interface card, plus 7VA for each programming card.

b) OPERATING TEMPERATURE RANGE: 0° to 70°C.

c) STORAGE TEMPERATURE: -25°C to 85°C.

d) INPUT: The Kepco 488 Programming System is connected to the GPIB bus by means of an interconnecting cable (Kepco Model SNC-1, -2 or -4), terminated at both ends with two standard 24-pin connectors.

Once connected to the GPIB, the Kepco 488 programming System must be addressed by the bus controller, transmitting the listener address byte followed by 9 (nine) data bytes see FIG. 1-4. All data bytes are ASCII (American Standard Code for Information Interchange) characters, sent on the bus according to the GPIB protocol.

(1) The "Kepco 488 Programming System", as described in this manual, consist of either a Kepco Model SNR 488-4 or SNR 488-8 RACK HOUSING and at least one (optional) Kepco Model SN 488-B or SN 488-D Programming Card.

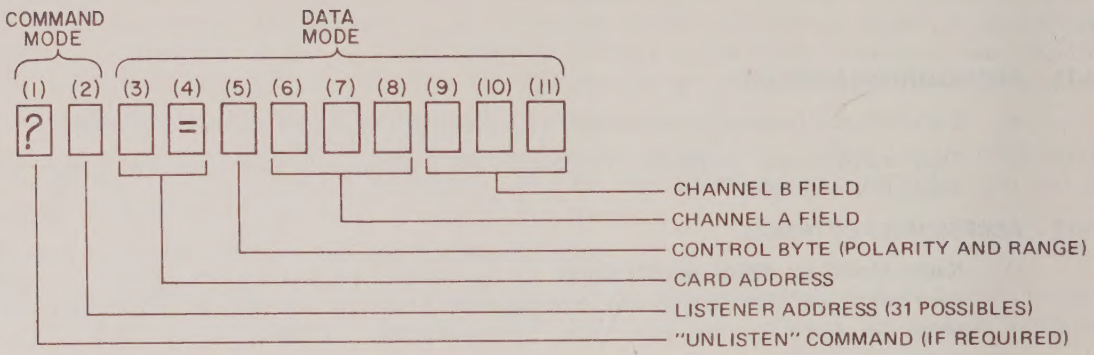


FIG. 1-4 INPUT DATA FORMAT AND SEQUENCE FOR KEPCO 488 PROGRAMMING SYSTEM.

Note: A data byte description is provided in Section III of this manual.

e) OUTPUT:
   1) HIGH RANGE: 0 to ± 10V d-c, 2mA max.
   2) LOW RANGE: 0 to ± 1V d-c, 2mA max.

f) ISOLATION: 1000V d-c isolation between digital input and analog output.

1-15 PERFORMANCE: Refer to Table 1-1.

SPECIFICATION	WITH MODEL SN 488-B PROGRAMMING CARD	WITH MODEL SN 488-D PROGRAMMING CARD
RESOLUTION	12 BIT (BINARY)	3 DIGIT (BCD)
LINEARITY	± 1/2 LSB	± 1/4 LSB
GAIN DRIFT	± 35 PPM/°C	± 35 PPM/°C
OFFSET DRIFT (High Range)	± 20 μV/°C	± 20 μV/°C
OFFSET DRIFT (Low Range)	± 10 μV/°C	± 10 μV/°C
OUTPUT CURRENT	2 MA MAX.	2 MA MAX.
OUTPUT IMPEDANCE	< 0.05 Ω	< 0.05 Ω

TABLE 1-1 PERFORMANCE SPECIFICATIONS, KEPCO 488 PROGRAMMING SYSTEM.

SECTION II -INSTALLATION

2-1 UNPACKING AND INSPECTION

2-2 All systems components have been thoroughly inspected and tested prior to packing and are ready for operation. After careful unpacking, inspect for shipping damage before attempting to operate. An off-line check-out may be performed by following the instruction provided in Section III (PAR. 3-16). If any indication of damage is found, file an immediate claim with the responsible transport service.

2-3 TERMINATIONS, MODEL SNR 488-4 (See FIG.'s 2-1, 2-2 and Table 2-1).

2-4 TERMINATIONS, MODEL SNR 488-8 (See FIG.'s 2-3, 2-4 and Table 2-1).

2-5 A-C SOURCE INPUT CONVERSION

2-6 The Kepco 488 Programming System is normally delivered for operation on a nominal 115V a-c source. Conversion for operation on 230V a-c sources requires the performance of the following steps:

1) Change MAIN FUSE (see FIG.'s 2-2, 2-4, Item 5) to one-half its former value (see Parts List for F201-230).

2) Change INTERFACE FUSE (see FIG.'s 2-2, 2-4 Item 8) to one-half its former value (see Parts List for F1-230).

3) Change FUSE on ***each*** of the Programming Boards to one-half their former value (see Programming Board Instruction Manual for location).

4) Set SOURCE VOLTAGE SELECTOR (see FIG.'s 2-2, 2-4, Item 8) to the "230" position.

5) Set SOURCE VOLTAGE SELECTOR on ***each*** of the Programming Boards (see Programming Board Instruction Manual for location) to the "230" position.

2-7 COOLING

2-8 Power dissipating components in the Kepco SN488 Programming System are cooled by convection. Rear panel and cover openings must be kept clear from obstructions to ensure proper air circulation.

2-9 Periodic cleaning of the cabinet's inside is recommended. If the cabinet is mounted into confined spaces (rack installations, etc.), care must be taken that the temperature 2" below the cabinet does not exceed 70°C.

2-10 INSTALLATION (Refer to FIG. 5-1 and 5-2 "MECHANICAL OUTLINE DRAWING").

2-11 MODEL SNR 488-4 or SN 488-8 RACK HOUSING: All SNR rack housings can be directly mounted into a standard (19-inch) instrument rack.

NOTE: CARE MUST BE TAKEN THAT THE TEMPERATURE SURROUNDING THE INSTALLED INSTRUMENT DOE NOT EXCEED 70°C.

2-12 MODEL SN 488-B or SN 488-D PROGRAMMING CARD: Loosen LOCKING SCREWS (ITEM 2 on FIG.'s 2-1 or 2-3) on SNR RACK HOUSING . Slide Programming Card into designated slot in the RACK HOUSING, using the board-mounted thumb lever. Close access cover on the RACK HOUSING and refasten the LOCKING SCREWS.

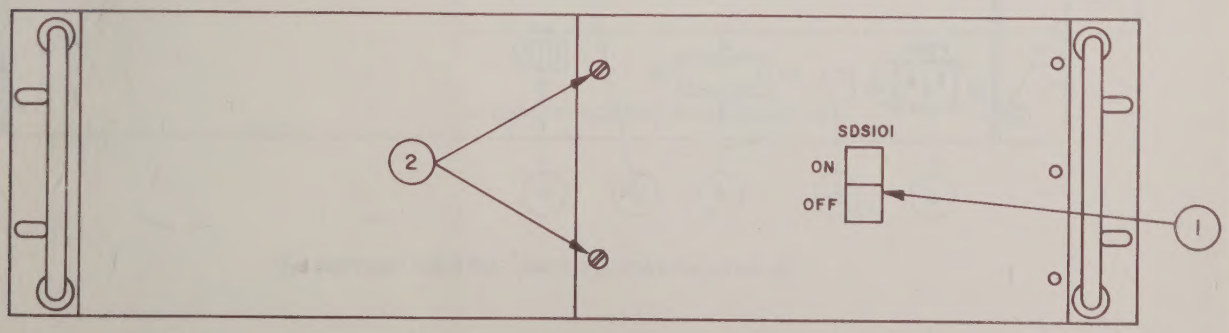


FIG. 2-1 FRONT PANEL, MODEL SNR 488-4 (See Table 2-1).

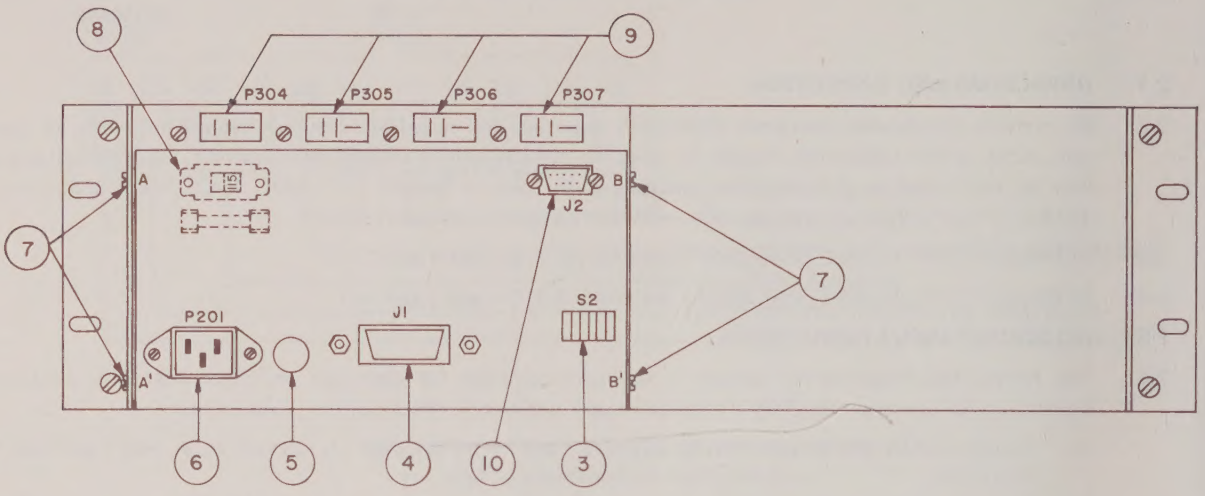


FIG. 2-2 REAR PANEL, MODEL SNR 488-4 (See Table 2-1).

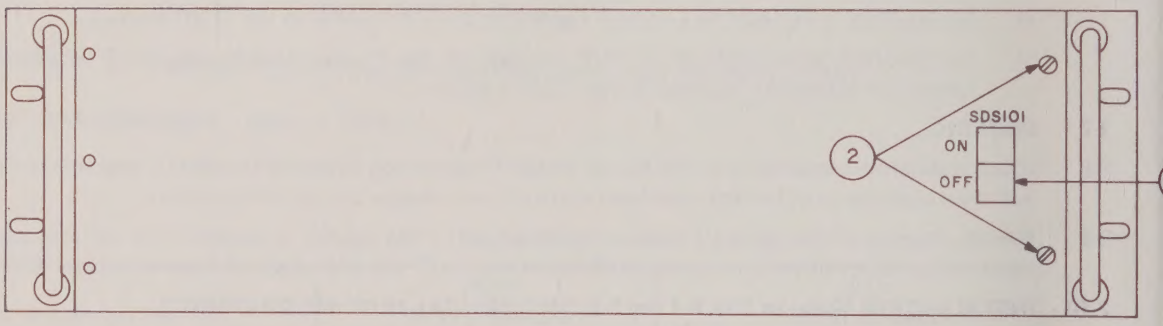


FIG. 2-3 FRONT PANEL, MODEL SNR 488-8 (See Table 2-1).

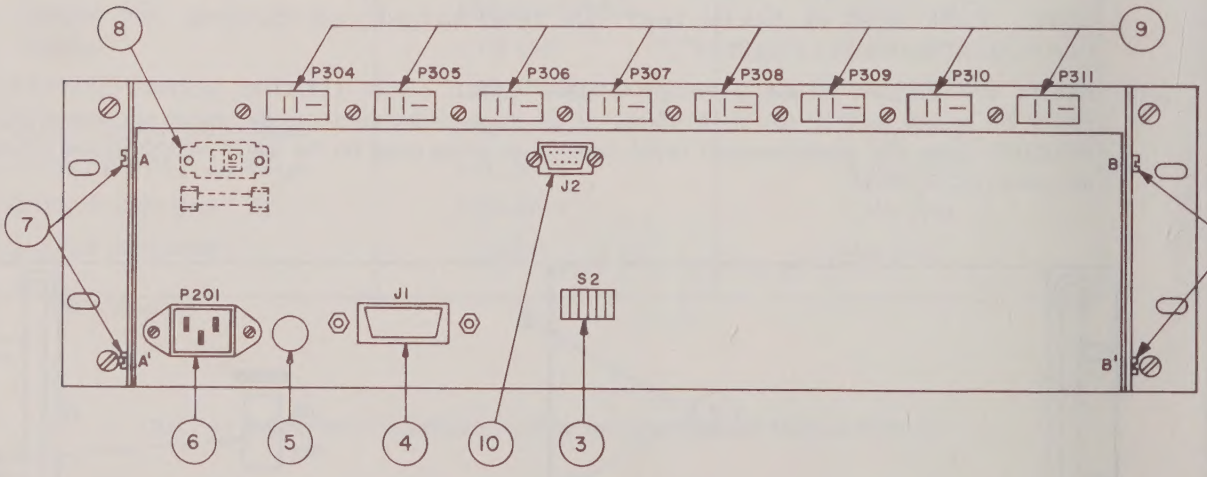


FIG. 2-4 REAR PANEL, MODEL SNR 488-8 (See Table 2-1).

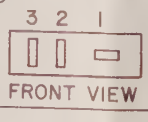
NO.	CONTROL OR TERMINATION	FUNCTION
1	A-C POWER SWITCH	A-C POWER LINE ON-OFF SWITCH, WITH "ON" LIGHT. APPLIES SOURCE POWER TO INTERFACE AND ALL PLUG-IN PROGRAMMING CARDS.
2	LOCKING SCREWS	WHEN LOOSENED, HINGED FRONT PANEL MAY BE OPENED FOR ACCESS TO PROGRAMMING CARD SLOTS.
3	ADDRESS SELECTOR	MULTIPLE ROCKER SWITCH, TO SET INTERFACE TO EITHER THE "LISTEN ONLY" MODE OR THE "ADDRESSABLE" MODE AND TO PRESET INTERFACE ADDRESS. SEE SECTION III FOR DETAILED INSTRUCTIONS.
4	EXT-BUS CONNECTOR	TO CONNECT INTERFACE TO GPIB BUS BY MEANS OF KEPCO MODEL SNC 488-1, -2 OR -4 CABLE.
5	FUSE HOLDER	MAIN FUSE, PROTECTS A-C INPUT CIRCUITRY TO ALL PROGRAMMING CARDS.
6	A-C LINE CORD	TO CONNECT INSTRUMENT TO A-C INPUT SOURCE.
7	REAR PANEL HOLDING-SCREWS	REMOVE SCREWS A,B AND LOOSEN SCREWS A',B' TO TILT HINGED REAR PANEL FOR ACCESS TO INTERFACE BOARD, INTERFACE FUSE AND SOURCE VOLTAGE SELECTOR SWITCH.
8	INTERFACE FUSE AND SOURCE-VOLTAGE SELECTOR	SEPARATE FUSE FOR INTERFACE A-C INPUT CIRCUIT AND SWITCH TO SELECT EITHER "115V AC" OR "230V AC" NOMINAL SOURCE INPUT (INTERFACE ONLY, PROGRAMMING CARDS HAVE THEIR OWN FUSE AND SOURCE SELECTOR).
9	OUTPUT CONNECTORS 1) Output Channel A 2) Output Channel B 3) Common  FRONT VIEW	ANALOG OUTPUTS FOR EACH PROGRAMMING CARD. MATING CONNECTORS SUPPLIED.
10	INT-BUS CONNECTOR	INTERNAL BUS ACCESS CONNECTOR. FOR INTERCONNECTING MODEL SN 488-K KEYBOARD BY MEANS OF KEPCO MODEL SNP 488-1, -2 OR -4 CABLE.

TABLE 2-1 TERMINATIONS, KEPCO SNR RACK HOUSINGS

SECTION III--OPERATION

3-1 GENERAL

3-2 Operation of the Kepco 488 Programming System on the GPIB bus requires four basic steps as follows:

1) Set Kepco 488 interface address
2) Set all programming card addresses
3) Establish Kepco 488 to power supply connections
4) System operation

These steps are described in detail in the following paragraphs.

3-3 SETTING THE KEPCO 488 INTERFACE ADDRESS

3-4 The GPIB bus address for the Kepco 488 Programming System is intially set by means of the ADDRESS SELECTOR switch as shown in FIG. 3-1.

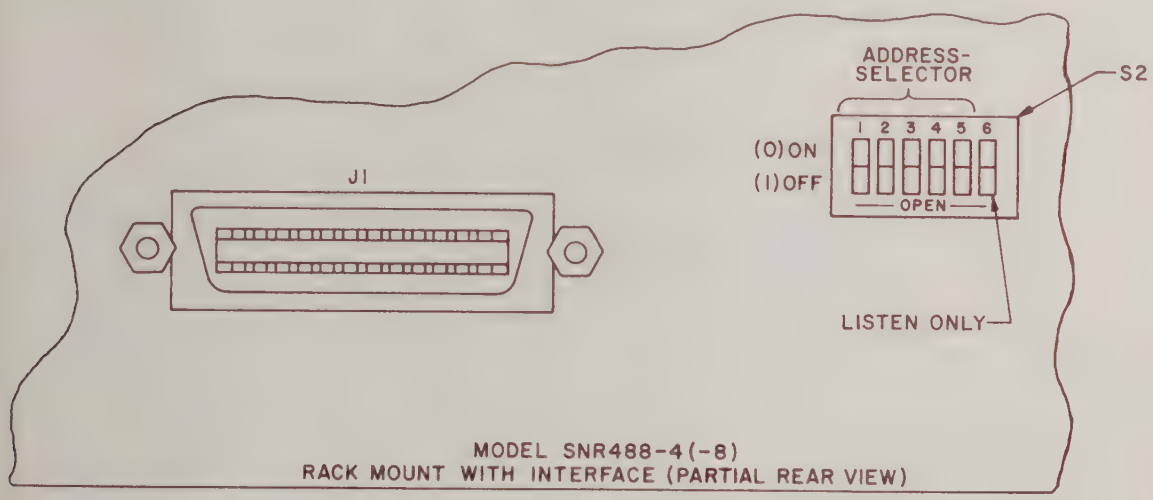


FIG. 3-1 LOCATION OF REAR PANEL BUS-ADDRESS SELECTOR SWITCHES.

3-5 The Kepco 488 address may be selected from thirty-one (31) ASCII characters as shown in Table 3-1.

ASCII CHARACTER	DECIMAL ADDRESS	ADDRESS SELECTOR SWITCH POSITIONS S1	S2	S3	S4	S5	LISTEN ONLY (S6)
NOT APPLICABLE		X	X	X	X	X	0
SP	0	0	0	0	0	0	1
!	1	1	0	0	0	0	1
"	2	0	1	0	0	0	1
#	3	1	1	0	0	0	1
$	4	0	0	1	0	0	1
%	5	1	0	1	0	0	1
&	6	0	1	1	0	0	1
'	7	1	1	1	0	0	1
(	8	0	0	0	1	0	1
)	9	1	0	0	1	0	1
*	10	0	1	0	1	0	1
+	11	1	1	0	1	0	1
,	12	0	0	1	1	0	1
-	13	1	0	1	1	0	1
.	14	0	1	1	1	0	1
/	15	1	1	1	1	0	1
0	16	0	0	0	0	1	1
1	17	1	0	0	0	1	1
2	18	0	1	0	0	1	1
3	19	1	1	0	0	1	1
4	20	0	0	1	0	1	1
5	21	1	0	1	0	1	1
6	22	0	1	1	0	1	1
7	23	1	1	1	0	1	1
8	24	0	0	0	1	1	1
9	25	1	0	0	1	1	1
:	26	0	1	0	1	1	1
;	27	1	1	0	1	1	1
<	28	0	0	1	1	1	1
=	29	1	0	1	1	1	1
>	30	0	1	1	1	1	1

X = DON'T CARE
0 = ON (SWITCH CLOSED)
1 = OFF (SWITCH OPEN)

PROGRAMMING NOTE:
The *complete* ASCII character (7-bits) must be programmed.

TABLE 3-1 LISTENING ADDRESS SELECTION ON THE KEPCO 488 PROGRAMMING SYSTEM.

3-6 SETTING THE PROGRAMMING CARD ADDRESS

3-7 The address for each programming card contained in the Kepco 488 system is initially set by means of an address switch (S1) located on each card as shown in FIG. 3-2.

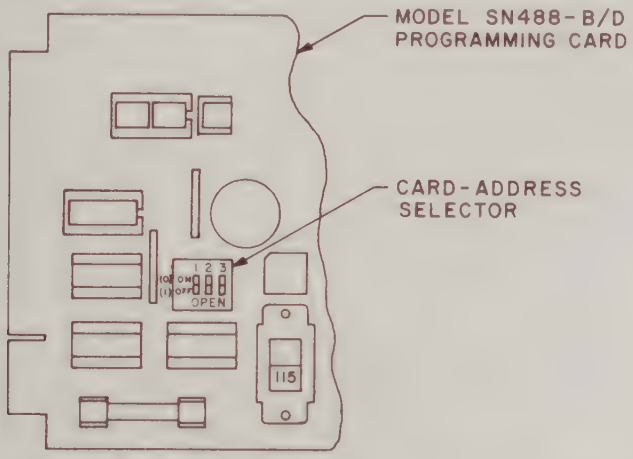


FIG. 3-2 LOCATION OF CARD ADDRESS SELECTOR SWITCH.

3-8 The card address may be selected from eight (8) ASCII characters as shown in Table 3-2.

ASCII CHARACTER	SWITCH POSITIONS S1	S2	S3
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

Programming Note:
The *complete* ASCII character (7 bits) must be programmed.
0 = On (Switch closed)
1 = Off (Switch open)

TABLE 3-2 CARD ADDRESS SELECTION ON THE KEPCO 488 PROGRAMMING SYSTEM.

3-9 MAKING THE CONNECTIONS BETWEEN THE KEPCO 488 SYSTEM AND THE POWER SUPPLY TO BE PROGRAMMED.

3-10 The Kepco 488 Programming System can control a wide variety of Kepco programmable power supplies. On some models, the output voltage and the current limit function can be controlled by means of a simple resistor connection, while others can be connected without any additional components. On many of the newer design groups, marked with superscript "(1)" , the output voltage and the output current can be controlled simultaneously, while on older design groups only single channel control can be exercised (current *or* voltage). Several basic interconnections are described in the following paragraphs. These circuits are chosen to deliver from zero to maximum rated output voltage and current, in response to the two analog output signals (0–10V and 0–1V), from a single programming card in the Kepco 488 system. The circuits may, however, be scaled to any desired ratio. Detailed information on each Kepco power supply model is contained in the individual power supply instruction manual.

NOTE: EITHER SIDE OF THE POWER SUPPLY OUTPUT MAY BE GROUNDED.

3-11 The table below (see Table 3-3) lists the major groups of Kepco programmable power supplies, suitable for operation with the Kepco 488 Programming System. From the table, the connection requirements can be quickly determined. For special requirements, please consult your Kepco Representative, or the Kepco Application Engineering Department, Flushing, New York.

KEPCO MODEL GROUP	PROGRAMMING SIGNAL FOR FULL OUTPUT		CONNECTIONS REQUIRED	
	VOLTAGE CONTROL	CURRENT CONTROL	VOLTAGE CONTROL	CURRENT CONTROL
* APH(1)	0–10V	0–1V	DIRECT CONNECTIONS	
ATE (1)	0–10V	0–1V	DIRECT CONNECTIONS	
* BHK(1)	0–1 mA	0–1V	See FIG. 3-3	See FIG. 3-5
BOP	0–1 mA	0–1V/0–0.5V(2)	See FIG. 3-3	See FIG. 3-4
CC	N.A.	0–1 mA	N.A.	See FIG. 3-4
CCP	0–1 mA	0–1 mA	See FIG. 3-3	See FIG. 3-4
JQE	0–1 mA	0–1V/0–0.5V(2)	See FIG. 3-3	See FIG. 3-4
JQE–Y(1)	0–1 mA	0–1V/0–0.5V(2)	See FIG. 3-3	See FIG. 3-5
JMK(1)	0–1 mA	0–1V/0–0.5V(2)	See FIG. 3-3	See FIG. 3-5
OPS–I,II	0–1 mA	0–1V	See FIG. 3-3	See FIG. 3-4
OPS–III to VIII(1)	0–1 mA	0–1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-5
* OPS–X(1)	0–1 mA	0–1V/0–0.5V(2)	See FIG. 3-3	See FIG. 3-5
* OPS IX-B(1)	0–1 mA	0–1V	See FIG. 3-3	See FIG. 3-5
PAT	0–1 mA	0–1V	See FIG. 3-3	See FIG. 3-4
PCX	0–1 mA	0–1V	See FIG. 3-3	See FIG. 3-4
PTR(1)	0–1 mA	0–1V	See FIG. 3-3	See FIG. 3-5

N.A. - NOT APPLICABLE.
(1) - SIMULTANEOUS VOLTAGE/CURRENT CONTROL POSSIBLE.
(2) - MODELS WITH OUTPUT CURRENT TO 5 AMPERES: 1V. MODELS WITH OUTPUT CURRENT 5 A AND GREATER: 0.5V.
* - FOR ALL UNITS OVER 1000 VOLTS, THE POSITIVE OUTPUT TERMINAL MUST BE GROUNDED

TABLE 3-3 KEPCO PROGRAMMABLE POWER SUPPLIES AND THEIR PROGRAMMING SIGNAL AND CONNECTION REQUIREMENTS.

3-12 OUTPUT VOLTAGE CONTROL. Many Kepco power supplies require a d-c control current of 0 to 1 mA for zero to maximum output in the voltage mode. This requirement is readily satisfied by connecting a series resistance of 10 K ohm as shown in FIG. 3-3.

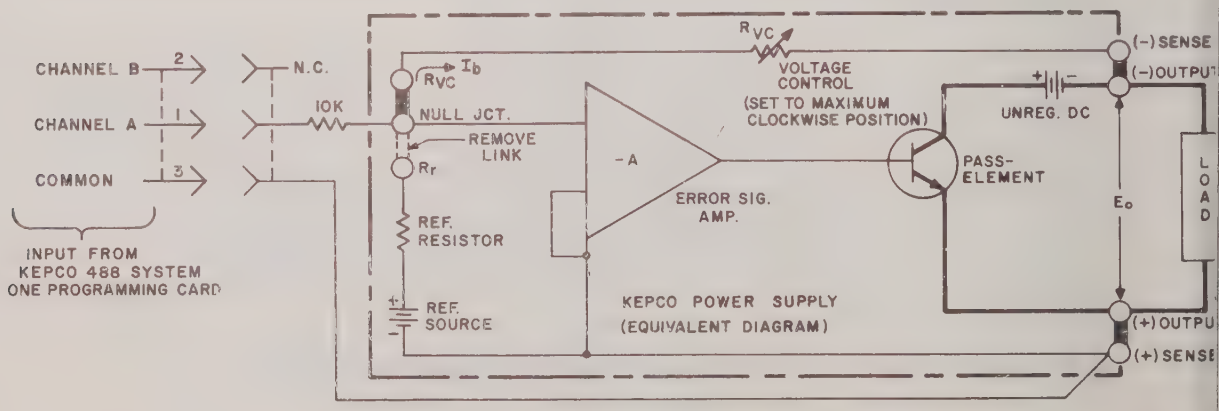


FIG. 3-3 OUTPUT VOLTAGE CONTROL WITH A TYPICAL KEPCO POWER SUPPLY AND THE KEPCO 488 SYSTEM.

3-13 Certain precautions should be observed when making the interconnection between the KEPCO 488 SYSTEM and the power supply:

1) The input leads to the power supply should be tightly twisted and shielded to protect against static and magnetic "pick-up".

2) The input leads should be as short as possible if the series resistor (R_i = 10 K ohm) is used as shown. If the input leads must be longer than a few inches, the input resistor should be placed close to the power supply's "Null Junction" terminal. Since the output from the KEPCO 488 SYSTEM is (without the resistor) a low impedance line, noise "pick-up" is greatly reduced in this manner.

3-14 OUTPUT CURRENT CONTROL. Kepco power supplies designed as current stabilizers (CC and CCP groups for example) as well as many Kepco voltage stabilizers connected for external current sensing and control may be controlled by the method shown previously for output voltage control (see PAR. 3-15). The illustration below (see FIG. 3-4) shows both cases. The component shown with dashed lines are added for current control with a voltage stabilized power supply. The previous remarks on interconnecting precautions (see PAR. 3-13). are equally valid in this case.

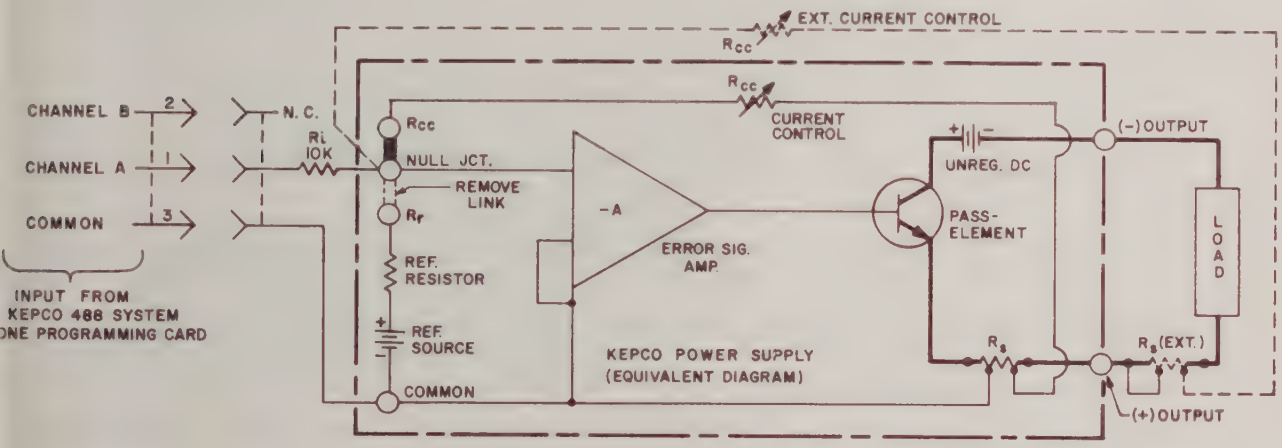


FIG. 3-4 OUTPUT CURRENT CONTROL USING A KEPCO CURRENT STABILIZED POWER SUPPLY OR A KEPCO VOLTAGE STABILIZED SUPPLY WITH EXTERNAL SENSING AND CONTROL RESISTOR (EXT. COMPONENTS, SHOWN WITH DASHED LINES).

3-15 COMBINED OUTPUT VOLTAGE/OUTPUT CURRENT CONTROL. For Kepco power supplies so identified in Table 3-3, the two channels (A,B) from a programming card in the Kepco 488 System may be used to control voltage and current output together, as shown in FIG. 3-5.

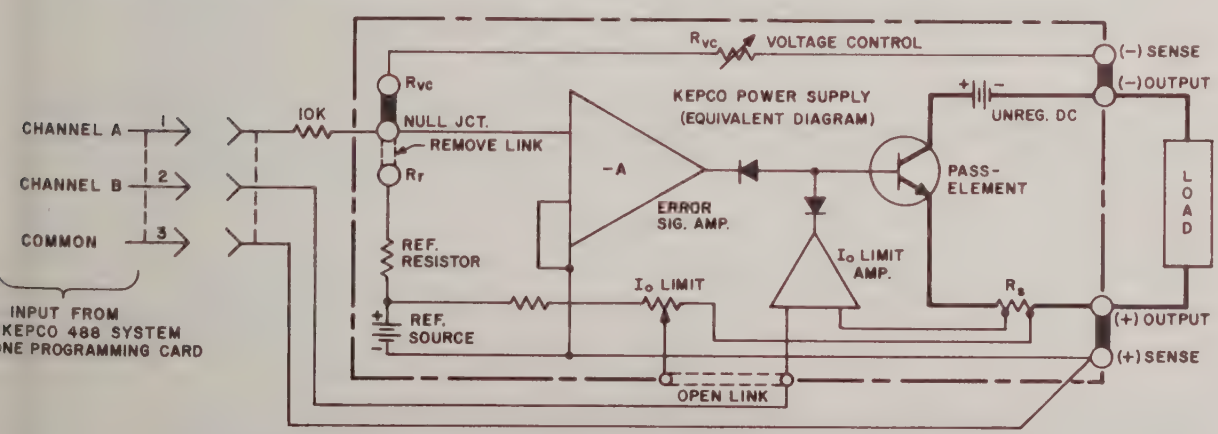
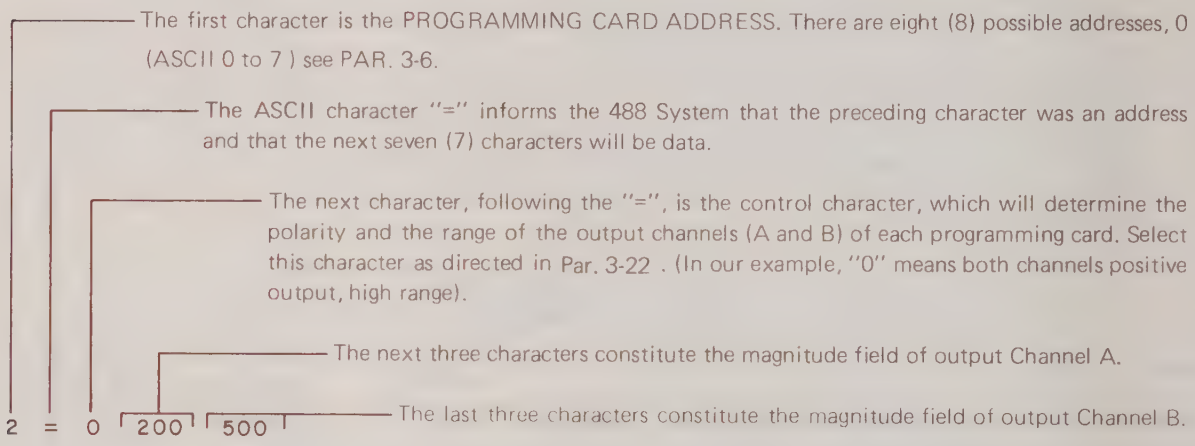


FIG. 3-5 COMBINED OUTPUT VOLTAGE/OUTPUT CURRENT CONTROL WITH A TYPICAL KEPCO POWER SUPPLY AND KEPCO 488 SYSTEM.

NOTE: On models requiring 0.5 volt current control voltage, a voltage divider, consisting of the two 500 ohm resistors, may be installed. System will yield 0 to full current output for 0–1 volt input from the programming card.

3-16 SYSTEM OPERATION

3-17 INSTRUCTION FORM. The Kepco SN 488 PROGRAMMING SYSTEM responds to an instruction of the form:


The first character is the PROGRAMMING CARD ADDRESS. There are eight (8) possible addresses, 0 (ASCII 0 to 7) see PAR. 3-6.
The ASCII character "=" informs the 488 System that the preceding character was an address and that the next seven (7) characters will be data.
The next character, following the "=", is the control character, which will determine the polarity and the range of the output channels (A and B) of each programming card. Select this character as directed in Par. 3-22 . (In our example, "0" means both channels positive output, high range).
The next three characters constitute the magnitude field of output Channel A.
The last three characters constitute the magnitude field of output Channel B.
2 = 0 200 500

3-18 The magnitude field characters for both output channels must be numerals 0 to 9 for the Model SN 488D (BCD) Programming Card. These characters represent an output voltage of (magnitude field ÷ 99.9)volts .

3-19 For the Model SN 488-B (binary) Programming Card, the magnitude field characters must be 0 to 9 or A to F. They form a 12-bit magnitude field represented as three hexadecimal characters. These characters represent an output voltage of (magnitude field ÷ 409.5) volts.

3-20 BLANKS. Blanks between instruction characters are permissible. They will be closed up by the SN-488 interface card circuit.

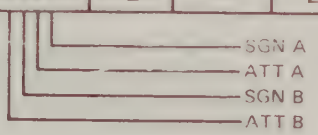
NOTE: AN INSTRUCTION MUST BE COMPLETE. INSTRUCTIONS OF FEWER THAN NINE (9) CHARACTERS WILL NOT BE EXECUTED BY THE PROGRAMMING CARD.

3-21 MULTIPLE CARD PROGRAM. Instructions for several cards may be strung together. The ASCII character "=" will serve as a delimiter, identifying each card address and its accompanying instruction fields. An example of a multiple card program is shown below:

0 = 03104001 = 05551002 = 0300200

3-22 CODING THE CONTROL CHARACTER. The character following "=" is the control character and determines the range and the polarity of the output channels. This character is converted by the SN 488 system into a 4-bit hexadecimal character resulting in the control possibilities shown in Table 3-4.

ASCII Character	Hex Data Byte	CHANNEL B Range	CHANNEL B Polarity	CHANNEL A Range	CHANNEL A Polarity
0	0000	H	+	H	+
1	0001	H	+	H	-
2	0010	H	+	L	+
3	0011	H	+	L	-
4	0100	H	-	H	+
5	0101	H	-	H	-
6	0110	H	-	L	+
7	0111	H	-	L	-
8	1000	L	+	H	+
9	1001	L	+	H	
A	1010	L	+	L	+
B	1011	L	+	L	-
C	1100	L	-	H	+
D	1101	L	-	H	-
E	1110	L	-	L	+
F	1111	L	-	L	



H = High Range, 0–10 Volts.
L = Low Range, 0–1 Volt.
+ = Positive with respect to analog common.
- = Negative with respect to analog common.

TABLE 3-4 CODING THE CONTROL CHARACTER.

3-23 INSTRUCTION EXAMPLES. The following examples illustrate typical instructions, executed by the programming cards.

3-24 EXAMPLE 1: SN-488 System with two Model SN 488D (BCD) programming cards with addresses 0 and 1.

a) To set Channel A of the card with address 0 to +5V and Channel B to -7.5V, the following instruction must be transmitted:

0 = 4499749

b) To set Channel A of the card with address 1 to -8.75V and Channel B to +0.5V, the following instruction is required:

1 = 1874050

Note: For increased resolution, Channel B of the card with address 1 may be switched to the LOW range by transmitting:

1 = 9874499

3-25 EXAMPLE 2: SN-488 System with two Model SN 488B (binary) programming card with addresses 0 and 1.

a) To set Channel A of the card with address 0 to +5V and Channel B to -7.5V, the following instruction must be transmitted:

0 = 47FFBFF

b) To set Channel A of the card with address 1 to -8.75V and Channel B to +0.5V, the following instruction is required:

1=1EØØØCD

Note: For increased resolution, Channel B of the card with address 1 may be switched to the LOW range by transmitting:

1=9E007FF

3-26 POWER SUPPLY CONTROL. When the Kepco SN-488 is used to control one or more system power supplies, we must know the instructions required to produce the correct output voltage and/or output current from the power supplies, rather than the output levels from the programming cards as in the previous examples.

3-27 All Kepco power supplies suitable for use with the SN-488 System and listed in Table 3-3 may be linearly controlled over their full output range by a 0 to 10 volt signal (voltage output) and by a 0 to 1V or 0 to 0.5V signal (current output). In most systems, therefore, a single programming card can be used per power supply, with one channel controlling the output voltage and the other the output current or current limit of the power supply.

3-28 To calculate the voltage field of the instruction sequence, the following quantities must be known:

a) Maximum power supply output voltage (V_1)
b) Control voltage required to produce the maximum output voltage (V_2)
c) Required power supply output voltage (V)

The voltage field (BCD) is then equal to:

$$\text{INTEGER} \quad \frac{99.9\ VV_2}{V_1}$$

or, to illustrate use of the basic language:

V$ = STR (INT (999*V*V_2/V_1))

3-29 When calculating the voltage field, the computer must always generate a three character field. Leading zeros must be included in the instruction when the output is small, so as to retain all three characters of the voltage field.

3-30 The current field may be programmed in a similar manner. The following quantities must be known:

a) Maximum power supply output current (I_1)
b) Control voltage required for maximum output current (I_2)
c) Required power supply output current (I)

The current field (BCD) is then equal to:

$$\text{INTEGER} \quad \frac{99.9\ I\ I_2}{I_1}$$

or, in basic:

I$ = STR (INT (999*I*I_2/I_1))

3-31 As in the case of the voltage field, the current field must contain three characters.

WARNING

BEFORE MAKING MEASUREMENTS AND/OR PERFORMING CALIBRATION ON THE KEPCO 488 SYSTEM, DISCONNECT THE POWER SUPPLY FROM THE ANALOG OUTPUT OF THE 488 SYSTEM.

IF MEASUREMENTS AND/OR CALIBRATIONS ARE PERFORMED WITH THE POWER SUPPLY CONNECTED, STANDARD HIGH-VOLTAGE PRECAUTIONS SHOULD BE EXERCISED, IF THE ANALOG "COMMON" OF THE 488 SYSTEM IS OPERATED "FLOATING".

3-32 SYSTEM CALIBRATION

3-33 POWER SUPPLY CALIBRATION. Before connecting the power supply to the SN-488 system, it should be carefully calibrated as described in the power supply instruction manual.

3-34 PROGRAMMING CARD CALIBRATION. Kepco Model SN 488-B/D Programming Cards are factory-calibrated and system tested before delivery to the customer. If re-calibration should be required, the following procedure should be used.

a) EQUIPMENT REQUIRED:

1) System Controller, or Kepco Model SN 488-K Keyboard

2) D-C Voltmeter, 0 to 10 volts, minimum accuracy ±.01%, minimum impedance 1000 ohms per volt (M1)

b) NOTE: FOR OPTIMUM ACCURACY, ALLOW A SYSTEM WARM-UP TIME OF AT LEAST 15 MINUTES.

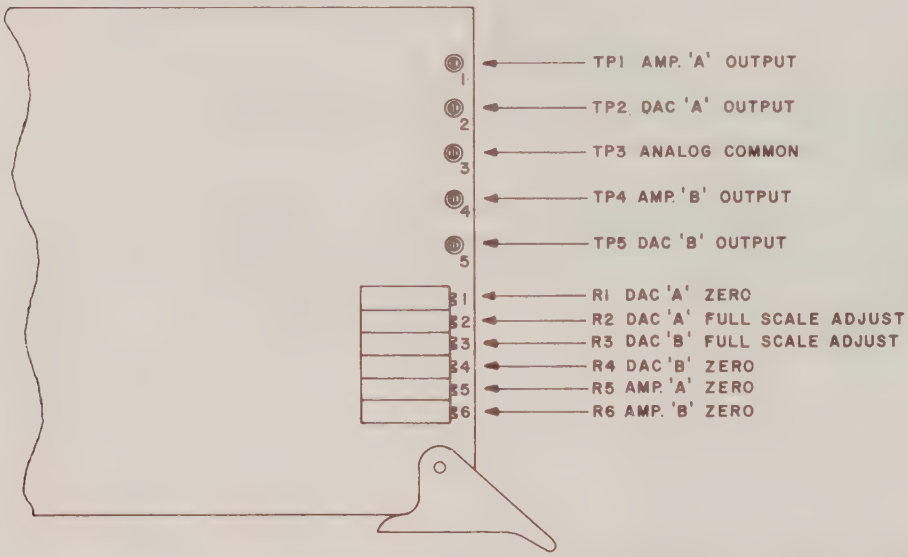

TP1 AMP. 'A' OUTPUT
TP2 DAC 'A' OUTPUT
TP3 ANALOG COMMON
TP4 AMP. 'B' OUTPUT
TP5 DAC 'B' OUTPUT
R1 DAC 'A' ZERO
R2 DAC 'A' FULL SCALE ADJUST
R3 DAC 'B' FULL SCALE ADJUST
R4 DAC 'B' ZERO
R5 AMP. 'A' ZERO
R6 AMP. 'B' ZERO

FIG. 3-6 LOCATION OF CALIBRATING CONTROLS AND TEST POINTS, KEPCO MODEL SN 488-B/D PROGRAMMING CARDS.

c) PROCEED AS FOLLOWS: (Refer to FIG. 3-6 for the location of test points and calibration controls)

STEP 1: Connect M1 (+) to TP2. Connect M1 (-) to TP3.

STEP 2: TRANSMIT: X = 0 000 000, where X is the card address, set as described in PAR. 3-6. This command will set both channels to zero volts. Check zero reading on M1 and correct, if necessary by adjusting R1.

STEP 3: Move M1 (+) to TP1. Check zero reading on M1 and correct by adjusting R5 if required.

STEP 4: Move M1 (+) to TP5. Check zero reading on M1 and correct by adjusting R4 if required.

STEP 5: Move M1 (+) to TP4. Check zero reading on M1 and correct by adjusting R6 if required.

STEP 6: TRANSMIT: X = 0 FFF FFF if Model SN 488-B Programming Card is used.
TRANSMIT: X = ~~0 999 999~~ gggg ggg if Model SN 488-D Programming Card is used.
Note: Substitute your selected card address for "X". Leave M1 connected as previously in Step 5.

STEP 7: Adjust R3 for 10V reading.

STEP 8: Move M1 (+) to TP1. Adjust R2 for ~~10V reading.~~ for full scale supply voltage

This concludes the calibration of the programming card.

3-35 FINAL CALIBRATION CHECK. Once the SN-488 system components are interconnected, the power supply output, following an instruction, should be checked for accuracy. Discrepancies between instructions and power supply output may be corrected by re-inserting the actual measured output values into the voltage and current field calculations (see PAR. 3-26 "Power Supply Control").

— TRANSMIT X = 8 000 010 ajust supply E_0 ZERO for ϕV out of supply

SECTION IV – THEORY OF OPERATION

4-1 GENERAL

4-2 BUS DESCRIPTION. The IEEE 488/GP-IB Interface Bus is an instrumentation interface which simplifies the integration of instruments and computers into measurement systems. It is not possible in this space to go into details, and only the functions pertaining to the Kepco 488 Programming System are briefly discussed here. The reader is referred to the "IEEE Standard Digital Interface for Programmable Instrumentation" (1975) for all relevant details.

4-3 The IEEE 488/GP-IB bus consists of an interconnecting cable, containing sixteen (16) signal lines which can be interconnected to up to fifteen (15) instruments. Each instrument is connected in parallel to the 16 lines of the bus. The cable's role is entirely passive and all active interface circuitry is contained in each instrument's interface circuitry.

4-4 Every participating device on the bus must be able to perform at least one of the roles of TALKER, LISTENER OR CONTROLLER. A TALKER can transmit data to other devices via the bus and a LISTENER can receive data from other devices. The CONTROLLER manages the operation of the bus system by designating which devices are to send and which are to receive data. A minimum system configuration on the IEEE 488/GP-IB bus consists of one TALKER and one LISTENER, but without a CONTROLLER. In this set-up, data transfer is limited to direct data transfer between the TALKER and the LISTENER, with the TALKER and LISTENER manually set to "talk only" and "listen only" respectively.

4-5 A more powerful configuration results, however, when one device (computer or calculator) which can serve as a CONTROLLER/TALKER/LISTENER is interconnected with other devices, serving as TALKERS and LISTENERS. The Kepco 488 Programming System is a LISTENER, capable of receiving data from other instruments and converting this data into analog signals which are in turn used to command the output of a programmable power supply.

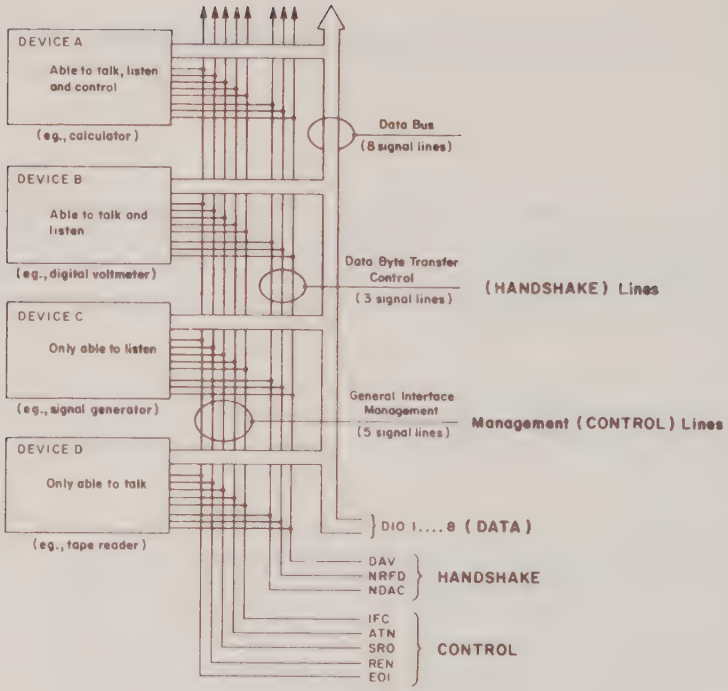


FIG. 4-1 INTERFACE CONNECTIONS AND BUS STRUCTURE

4-6 BUS STRUCTURE (see FIG. 4-1). The 16 signal lines of the passive interconnecting cable of the IEEE 488/GP–IB bus are divided into three functional groups:

1) Eight DATA lines carry coded messages in bit-parallel, byte-serial from a TALKER to one or more LISTENERS. Data flow is bi-directional and asynchronous, ensuring compatibility among devices with varying response times. Asynchronous transmission is accomplished by means of the DATA BYTE TRANSFER CONTROL LINES, described in PAR. 4-6 (2). Normally a 7-bit ASCII Code (American Standard Code for Information Interchange) is used for all messages.

2) Three DATA BYTE TRANSFER CONTROL ("Handshake") lines are used to effect the asynchronous transfer of all coded data bytes on the DATA lines.

3) Five GENERAL INTERFACE MANAGEMENT lines are used to control the orderly information flow on the bus. The Kepco 488 Programming System, as a LISTENER, is concerned only with the ATN line and the IFC line.

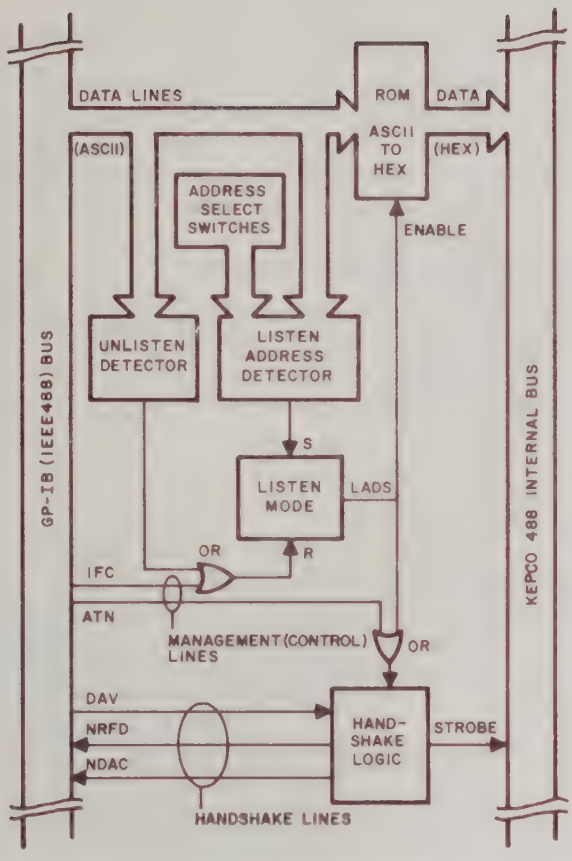


FIG. 4-2 KEPCO 488 PROGRAMMING SYSTEM, INTERFACE SIGNAL FLOW.

4-7 KEPCO 488 INTERFACE SIGNAL FLOW DESCRIPTION (see FIG. 4-2).

4-8 The active interface circuitry in the Kepco 488 Programming System implements the function of a LISTENER, as defined by the IEEE 488 Standard. The functional diagram (FIG. 4-2) shows the three groups of signal lines corresponding with the external IEEE 488/GP-IB bus on the left side, while the outgoing signal lines to the internal Kepco bus are shown on the right.

4-9 The state of the Kepco Interface is determined by the LADS flip-flop. If the ***interface listen address*** is received while ATN is low, the flip-flop is set and the interface enters the ***listener addressed state.*** If the ***unlisten command*** is received while ATN is low, the LADS flip-flop is reset and the interface exits the ***listener active state.*** The interface may be placed in the ***listen only*** mode by means of a switch located on the rear panel (S6). In this mode of operation, the interface is locked into the ***listener active state*** and will ignore the ***unlisten*** command.

4-11 While the interface is in the ***listener addressed state,*** ASCII data received via the 488 Bus is converted to hexadecimal format by the ROM and passed to the KEPCO INTERNAL BUS

4-12 KEPCO 488 PROGRAMMING CARD DESCRIPTION

4-13 The Kepco Programming Card, when connected to the INTERNAL BUS of the Kepco 488 Programming System, accepts digital information in the form of hexadecimal data bytes, either via the IEEE 488/GPIB BUS, or from a manual keyboard which may be connected to the INTERNAL BUS of the Kepco 488 System. The digital input is converted to analog outputs by D/A converters, producing two channels (A,B) with an output of plus or minus zero to ten volts at 2mA. The digital input is isolated from the analog output by means of optical isolators so that the digital ground is completely independent from the analog ground (up to 1000V d-c).

4-14 KEPCO 488 PROGRAMMING CARD, SIGNAL FLOW DESCRIPTION (see FIG. 4-4).

4-15 The input of the programming card is connected to the Kepco INTERNAL BUS and receives digital input signals in the form of hexadecimal data bytes in the sequence shown in FIG. 4-3. A total of nine (9) data bytes, plus a data transfer strobe following each byte constitutes a complete card instruction sequence (data byte coding has been described in Section III of this manual).

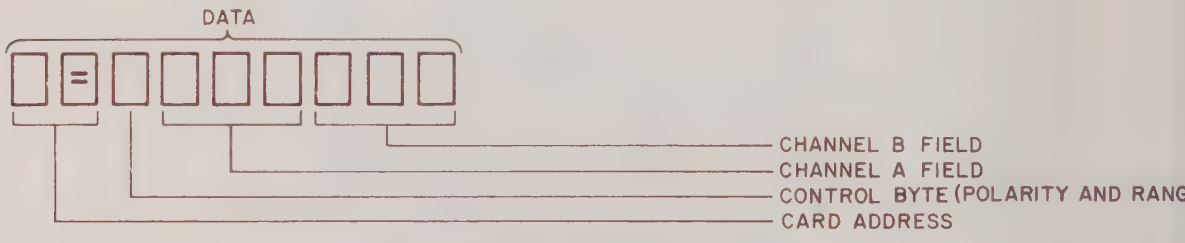


FIG. 4-3 DATA FORMAT AND SEQUENCE, KEPCO MODEL SN 488-B/D PROGRAMMING CARD

4-16 The first three data lines are monitored by the CARD ADDRESS DETECTOR, consisting of the ADDRESS SELECTOR SWITCH and a triple exclusive NOR gate. If the content of the three data lines and the switch positions coincide, the card address is correct and the MCA signal is applied to the CONTROL LOGIC. If the subsequent incoming signal is identified as the ASCII character "=" on its separate line, the control circuit enables the transfer of the next seven data bytes, as well as a SHIFT and a LATCH signal, across the OPTO ISOLATORS.

4-17 The data bytes are now entered into the SHIFT REGISTERS by means of the SHIFT command, which enables the SHIFT REGISTERS until all seven data bytes are placed. Following the last data byte, the LATCH command strobes the parallel data into the LATCHES. The data bytes representing the Channel A and Channel B fields are applied to the digital/analog converters (DAC-A,B) respectively, while the RANGE AND POLARITY BYTE is transferred to the control circuits which establish the amplifier polarity and output range. The amplifier outputs (0 to ±10V with reference to the analog common) are presented at the analog output connector.

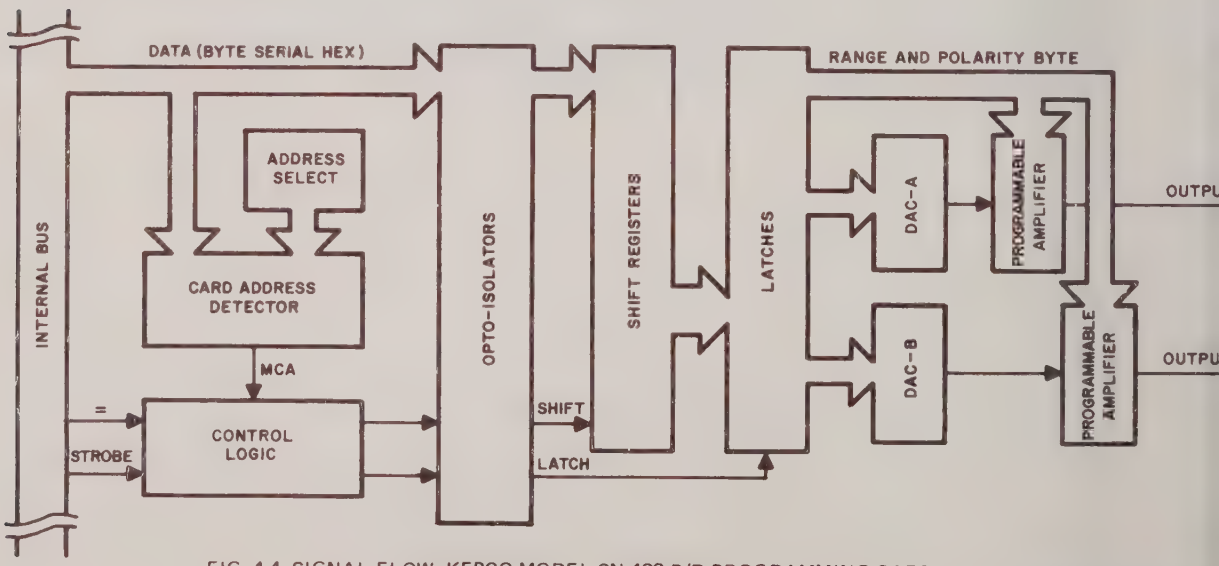


FIG. 4-4 SIGNAL FLOW, KEPCO MODEL SN 488-B/D PROGRAMMING CARD.

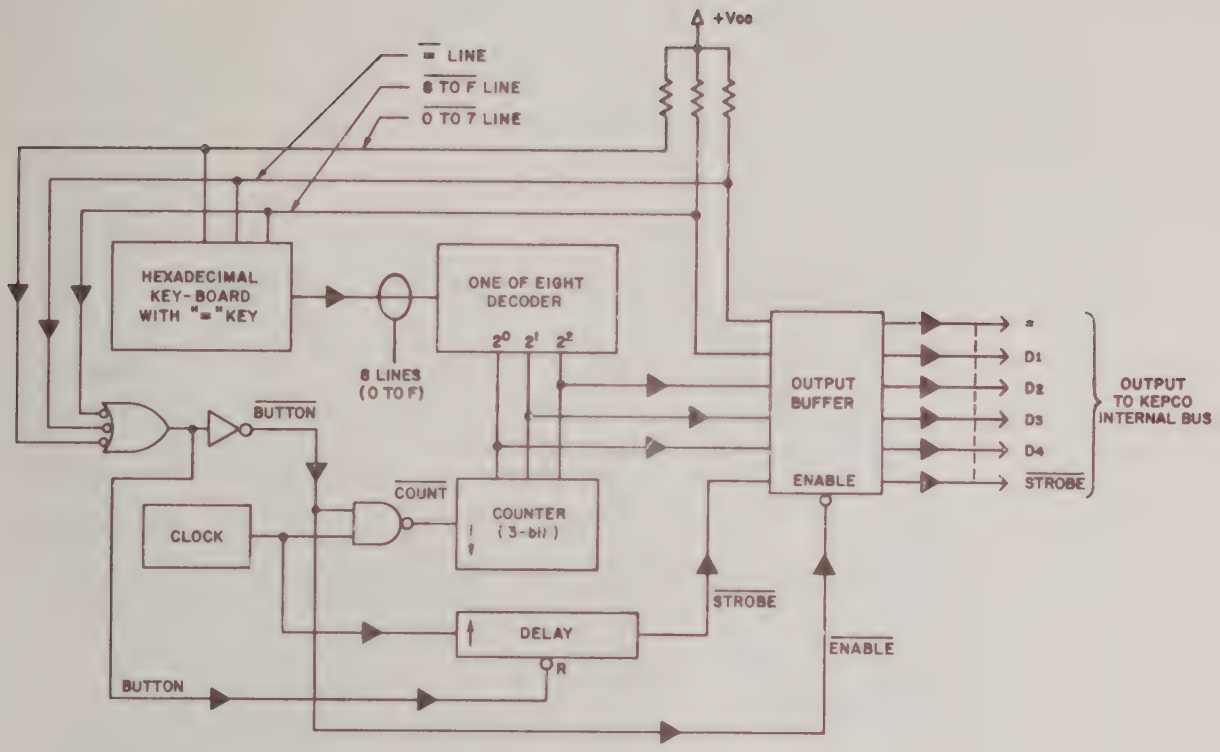


FIG. 4-5 SIMPLIFIED SIGNAL FLOW DIAGRAM, KEPCO MODEL SN 488-K

4-18 KEPCO 488 (OPTIONAL) KEYBOARD, SIGNAL FLOW DIAGRAM DESCRIPTION (See FIG. 4-5).

4-19 The Kepco Model SN 488-K is a hand-held, hexadecimal keyboard, capable of addressing the KEPCO INTERNAL BUS and thereby manually controlling the outputs of all programming cards connected to the Kepco488 Bus. The Kepco Model SN 488-K is primarily intended for use in testing and calibration of the Kepco 488 Programming System. The operating voltages for the Model SN 488-K are derived from the Kepco Model SNR 488-4 or SNR 488-8 and applied to the keyboard via the INPUT/OUTPUT bus connector.

4-20 The free-running (1 KHz) CLOCK produces a symmetrical square wave output, which is applied simultaneously to the NAND gate and to the DELAY circuit. Clocked by the COUNT Line, the 3-bit BCD COUNTER starts a continuous counting sequence, returning to zero on the eighth count. The counter output is connected simultaneously to the ONE OF EIGHT DECODER and to the OUTPUT BUFFER.

4-21 If one of the hexadecimal keyboard buttons is depressed, either the "$\overline{8 \text{ to } F}$" or the "$\overline{0 \text{ to } 7}$" LINE is set low as soon as the BCD COUNTER reaches the count corresponding to the depressed button. As a result, the BUTTON signal and its complement ($\overline{\text{BUTTON}}$) is generated. While the BUTTON signal starts the DELAY circuit, the $\overline{\text{BUTTON}}$ signal stops the BCD COUNTER and enables the OUTPUT BUFFER stage. Simultaneously, the BCD COUNTER output is presented to the DATA LINES (D1 to D4) via the OUTPUT BUFFER. Following a delay of about 8 milliseconds (to avoid erroneous data transfers due to keyboard switch bouncing) the $\overline{\text{STROBE}}$ signal is delivered to the OUTPUT BUFFER, thus completing the data transfer to the connected Programming Card.

4-22 If the "=" key is depressed, similar action takes place, i.e., the $\overline{\text{BUTTON}}$ signal stops the BCD COUNTER and enables the output buffer, while the BUTTON signal resets the DELAY. Following the delay action, the "=" signal is transferred via the OUTPUT BUFFER to the keyboard output.

SECTION V – ELECTRICAL PARTS LIST AND DIAGRAMS

5-1 GENERAL

5-2 This section contains the main schematic, the parts location diagrams, and a list of all replaceable electrical parts. All components are listed in alpha-numerical order of their reference designations. Consult your Kepco Representative for replacement of parts not listed here.

5-3 ORDERING INFORMATION

5-4 To order a replacement part or to inquire about parts not listed in the parts list, address order or inquiry either to your authorized Kepco Sales Representative or to

KEPCO, INC.
131-38 Sanford Avenue
Flushing, New York 11352, USA

5-5 Specify the following information for each part

a) Model and complete serial number of instrument.

b) Kepco part number.

c) Circuit reference designator.

d) Description.

5-6 To order a part not listed in the parts list, give complete description and include its function and location

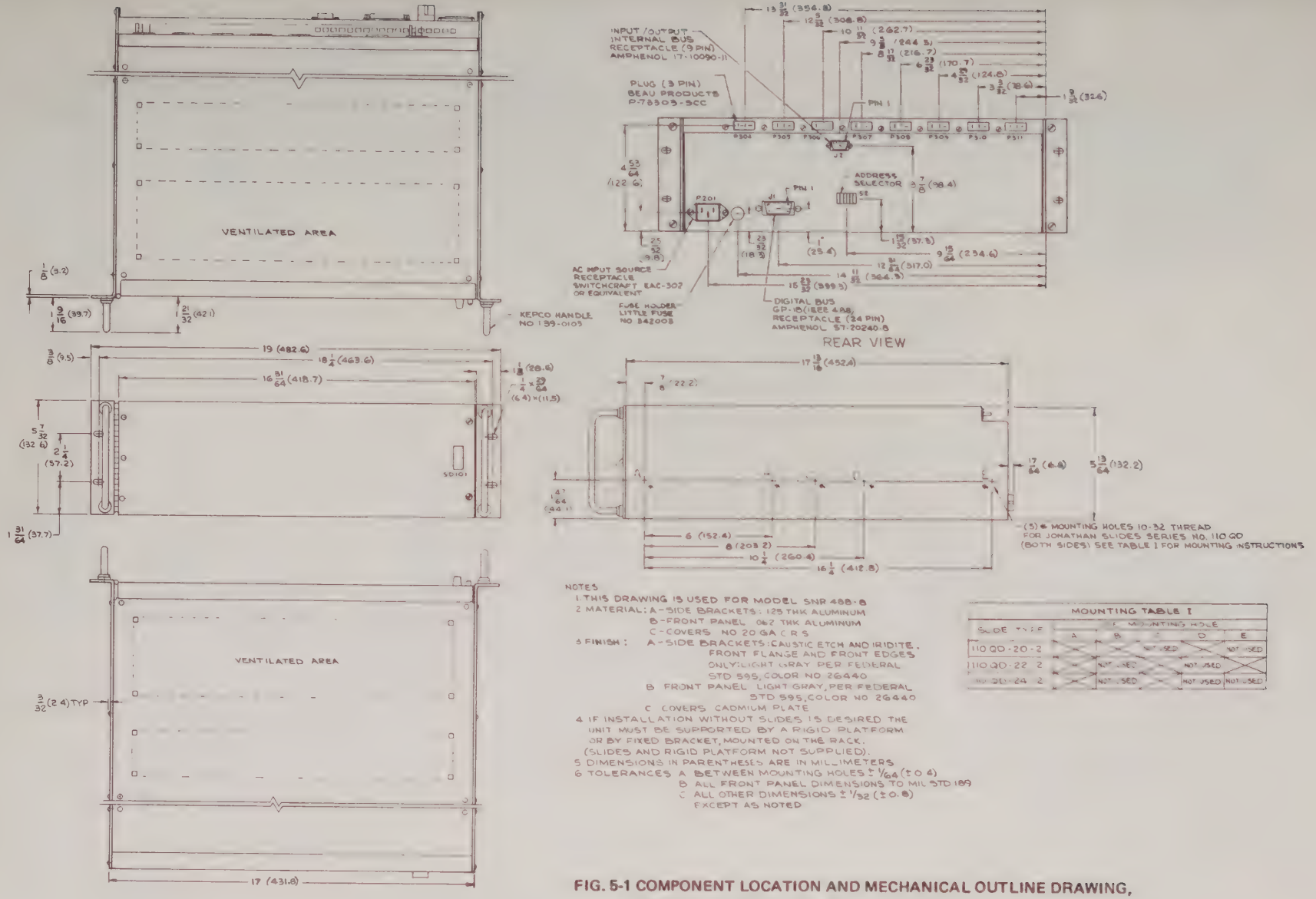
ABBREVIATIONS USED IN KEPCO PARTS LISTS

A) Reference Designators:

A	= Assembly
B	= Blower (Fan)
C	= Capacitor
CB	= Circuit Breaker
CR	= Diode
DS	= Device, Signaling (Lamp)
F	= Fuse
FX	= Fuse Holder
IC	= Integrated Circuit
J	= Jack
K	= Relay
L	= Inductor
LC	= Light-Coupled Device
M	= Meter
P	= Plug
Q	= Transistor
R	= Resistor
S	= Switch
T	= Transformer
TB	= Terminal Block
V	= Vacuum Tube
X	= Socket

B) Descriptive Abbreviations

A	= Ampere
a-c	= Alternating Current
AMP	= Amplifier
AX	= Axial
CAP	= Capacitor
CER	= Ceramic
CT	= Center-Tap
°C	= Degree Centigrade
d-c	= Direct Current
DPDT	= Double Pole, Double Throw
DPST	= Double Pole, Single Throw
ELECT	= Electrolytic
F	= Farad
FILM	= Polyester Film
FLAM	= Flammable
FP	= Flame-Proof
°F	= Degree Fahrenheit
FXD	= Fixed
Ge	= Germanium
H	= Henry
Hz	= Hertz
IC	= Integrated Circuit
K	= Kilo (10^3)
m	= Milli (10^{-3})
M	= Mega (10^6)
MFR	= Manufacturer
MET	= Metal
n	= Nano (10^{-9})
NC	= Normally Closed
NO	= Normally Open
p	= Pico (10^{-12})
PC	= Printed Circuit
POT	= Potentiometer
PIV	= Peak Inverse Voltage
p-p	= Peak to Peak
ppm	= Parts Per Million
PWR	= Power
RAD	= Radial
RECT	= Rectifier
RECY	= Recovery
REG	= Regulated
RES	= Resistor
RMS	= Root Mean Square
Si	= Silicon
S-End	= Single Ended
SPDT	= Single Pole, Double Throw
SPST	= Single Pole, Single Throw
Stud Mt	= Stud Mounted
TAN	= Tantalum
TSTR	= Transistor
μ	= Micro (μ) (10^{-6})
V	= Volt
W	= Watt
WW	= Wire Wound


VENTILATED AREA
REAR VIEW
INPUT/OUTPUT INTERNAL BUS RECEPTACLE (9 PIN) AMPHENOL 17-10090-11
PLUG (3 PIN) BEAU PRODUCTS P-78303-SCC
PIN 1
ADDRESS SELECTOR
AC INPUT SOURCE RECEPTACLE SWITCHCRAFT EAC-302 OR EQUIVALENT
FUSE HOLDER LITTLE FUSE NO 342008
KEPCO HANDLE NO 139-0105
DIGITAL BUS GP-IB (IEEE 488) RECEPTACLE (24 PIN) AMPHENOL 57-20240-8
(5) ⌀ MOUNTING HOLES 10-32 THREAD FOR JONATHAN SLIDES SERIES NO. 110 QD (BOTH SIDES) SEE TABLE I FOR MOUNTING INSTRUCTIONS
VENTILATED AREA
17 (431.8)

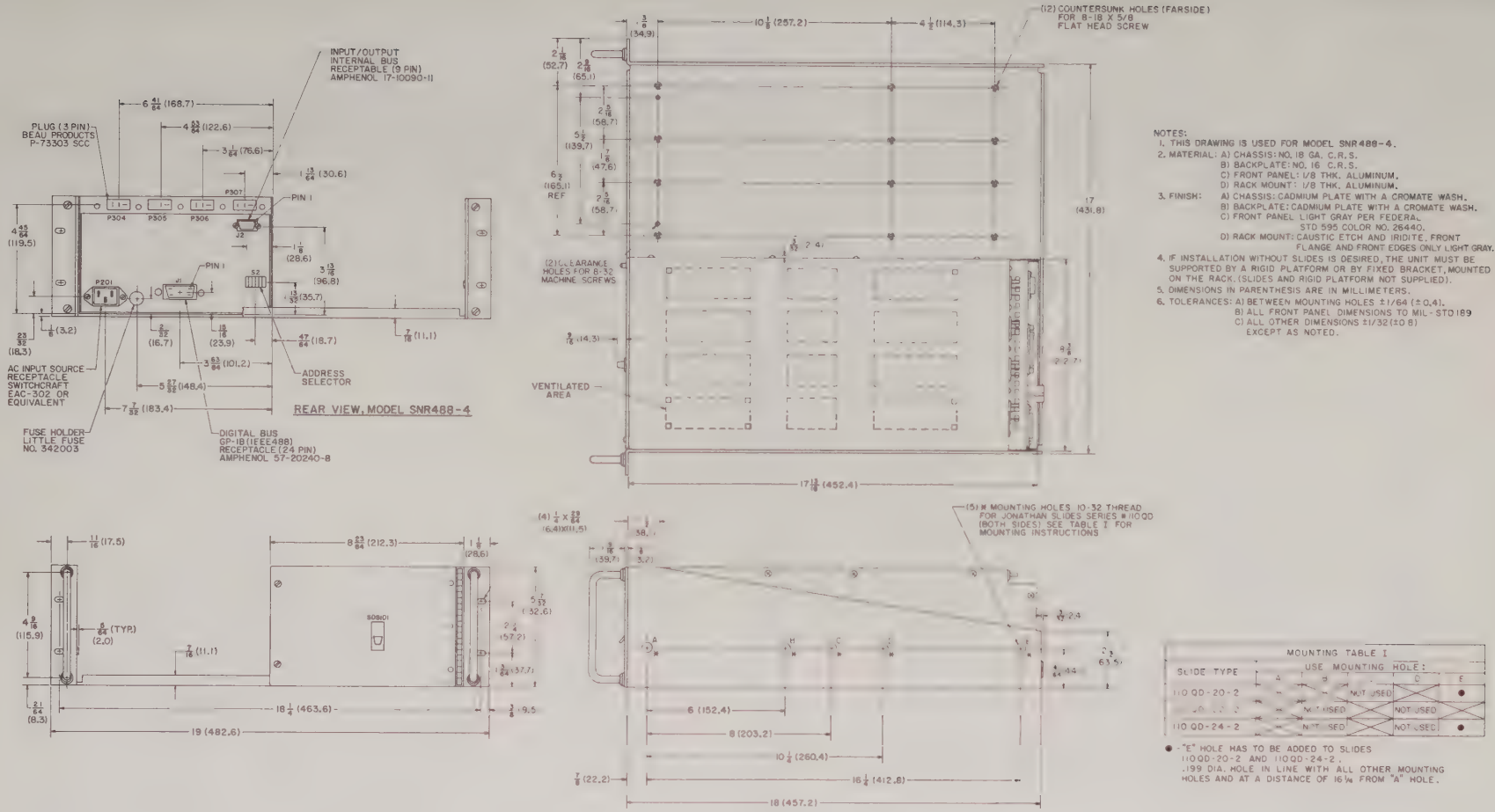
NOTES

1. THIS DRAWING IS USED FOR MODEL SNR 488-8
2. MATERIAL: A - SIDE BRACKETS: .125 THK ALUMINUM
   B - FRONT PANEL .062 THK ALUMINUM
   C - COVERS NO 20 GA C R S
3. FINISH: A - SIDE BRACKETS: CAUSTIC ETCH AND IRIDITE. FRONT FLANGE AND FRONT EDGES ONLY: LIGHT GRAY PER FEDERAL STD 595, COLOR NO 26440
   B FRONT PANEL LIGHT GRAY, PER FEDERAL STD 595, COLOR NO 26440
   C COVERS CADMIUM PLATE
4. IF INSTALLATION WITHOUT SLIDES IS DESIRED THE UNIT MUST BE SUPPORTED BY A RIGID PLATFORM OR BY FIXED BRACKET, MOUNTED ON THE RACK. (SLIDES AND RIGID PLATFORM NOT SUPPLIED).
5. DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS
6. TOLERANCES A BETWEEN MOUNTING HOLES ± 1/64 (± 0.4)
   B ALL FRONT PANEL DIMENSIONS TO MIL STD 189
   C ALL OTHER DIMENSIONS ± 1/32 (± 0.8) EXCEPT AS NOTED

MOUNTING TABLE I

SLIDE TYPE	MOUNTING HOLE A	B	D	E
110 QD-20-2	X	X	NOT USED	NOT USED
110 QD-22-2	X	NOT USED	NOT USED	X
110 QD-24-2	X	NOT USED	NOT USED	NOT USED

FIG. 5-1 COMPONENT LOCATION AND MECHANICAL OUTLINE DRAWING, KEPCO MODEL SNR 488—8 RACK CABINET


INPUT/OUTPUT INTERNAL BUS RECEPTABLE (9 PIN) AMPHENOL 17-10090-11
PLUG (3 PIN) BEAU PRODUCTS P-73303 SCC
P304
P305
P306
P307
J2
PIN 1
P201
J1
S2
AC INPUT SOURCE RECEPTACLE SWITCHCRAFT EAC-302 OR EQUIVALENT
FUSE HOLDER LITTLE FUSE NO. 342003
DIGITAL BUS GP-IB (IEEE488) RECEPTACLE (24 PIN) AMPHENOL 57-20240-8
ADDRESS SELECTOR
REAR VIEW, MODEL SNR488-4
(12) COUNTERSUNK HOLES (FARSIDE) FOR 8-18 X 5/8 FLAT HEAD SCREW
(2) CLEARANCE HOLES FOR 8-32 MACHINE SCREWS
VENTILATED AREA
17 (431.8)
17 1/8 (452.4)
(4) 1/4 X 23/64 (6.4)X(11.5)
(5) M MOUNTING HOLES 10-32 THREAD FOR JONATHAN SLIDES SERIES #110QD (BOTH SIDES) SEE TABLE I FOR MOUNTING INSTRUCTIONS
6 (152.4)
8 (203.2)
10 1/4 (260.4)
16 1/4 (412.8)
18 (457.2)
19 (482.6)

NOTES:
1. THIS DRAWING IS USED FOR MODEL SNR488-4.
2. MATERIAL: A) CHASSIS: NO. 18 GA. C.R.S.
   B) BACKPLATE: NO. 16 C.R.S.
   C) FRONT PANEL: 1/8 THK. ALUMINUM.
   D) RACK MOUNT: 1/8 THK. ALUMINUM.
3. FINISH: A) CHASSIS: CADMIUM PLATE WITH A CROMATE WASH.
   B) BACKPLATE: CADMIUM PLATE WITH A CROMATE WASH.
   C) FRONT PANEL LIGHT GRAY PER FEDERAL STD 595 COLOR NO. 26440.
   D) RACK MOUNT: CAUSTIC ETCH AND IRIDITE, FRONT FLANGE AND FRONT EDGES ONLY LIGHT GRAY.
4. IF INSTALLATION WITHOUT SLIDES IS DESIRED, THE UNIT MUST BE SUPPORTED BY A RIGID PLATFORM OR BY FIXED BRACKET, MOUNTED ON THE RACK. (SLIDES AND RIGID PLATFORM NOT SUPPLIED).
5. DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS.
6. TOLERANCES: A) BETWEEN MOUNTING HOLES ±1/64 (±0.4).
   B) ALL FRONT PANEL DIMENSIONS TO MIL-STD 189
   C) ALL OTHER DIMENSIONS ±1/32 (±0.8) EXCEPT AS NOTED.

MOUNTING TABLE I

SLIDE TYPE	USE MOUNTING HOLE: A	B	C	E
110 QD-20-2		NOT USED		●
110 QD-22-2		NOT USED	NOT USED	
110 QD-24-2		NOT USED	NOT USED	●

● - "E" HOLE HAS TO BE ADDED TO SLIDES 110QD-20-2 AND 110QD-24-2. .199 DIA. HOLE IN LINE WITH ALL OTHER MOUNTING HOLES AND AT A DISTANCE OF 16 1/4 FROM "A" HOLE.

FIG. 5-2 COMPONENT LOCATION AND MECHANICAL OUTLINE DRAWING, KEPCO MODEL SNR 488-4 RACK CABINET (A2).

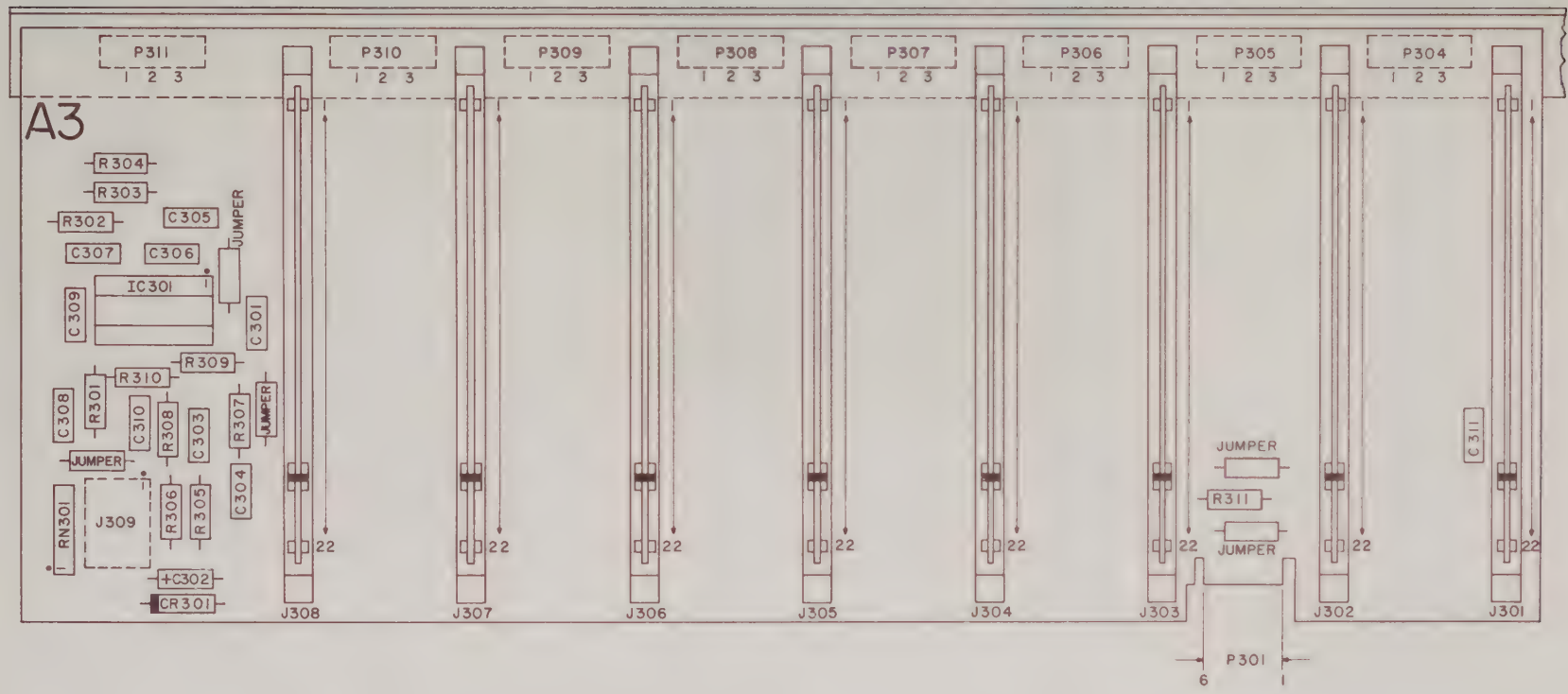


FIG. 5-3 COMPONENT LOCATION, MODEL SNR 488–8, MOTHERBOARD (A3).

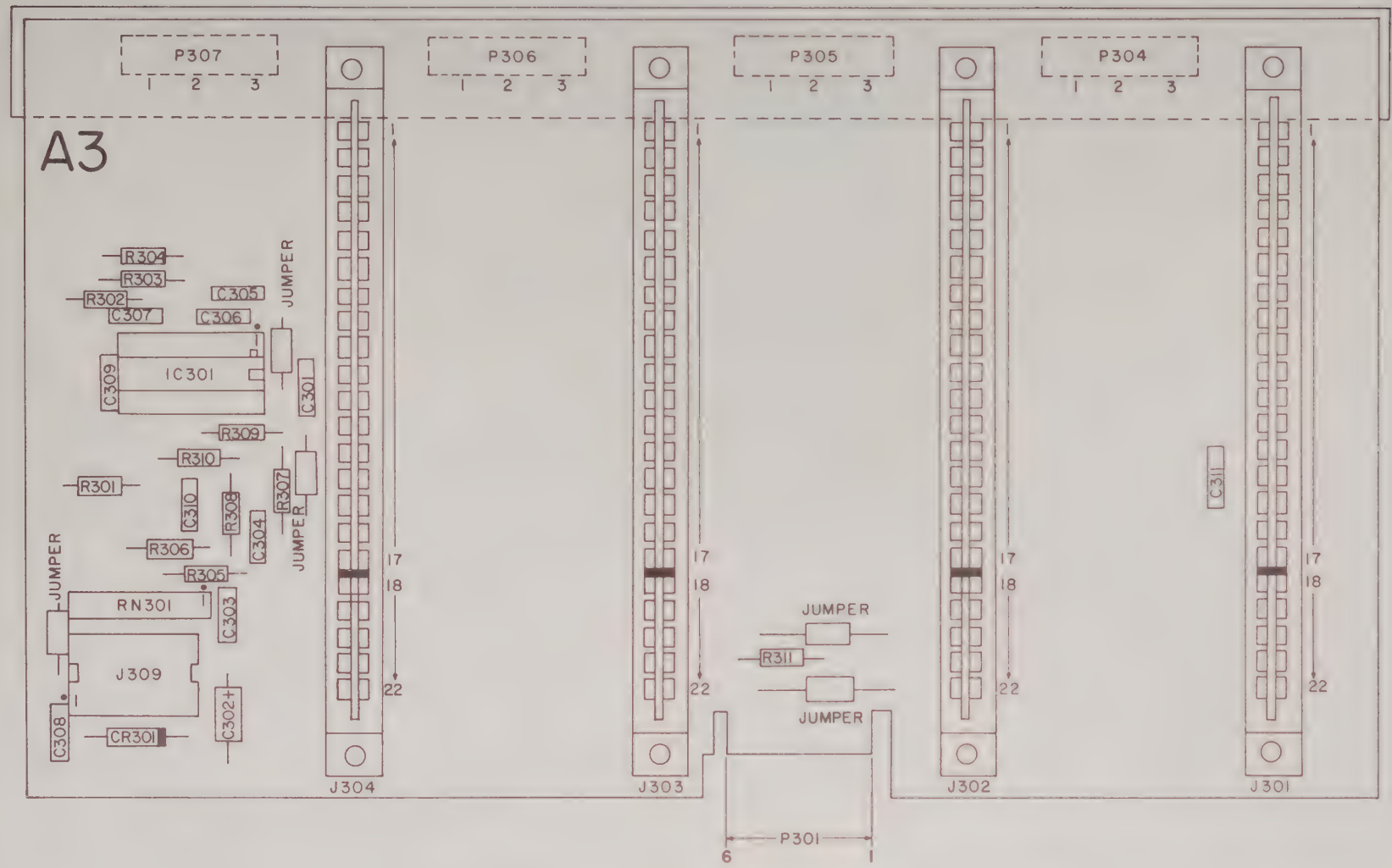


FIG. 5-4 COMPONENT LOCATION, MODEL SNR 488–4, MOTHERBOARD (A3).

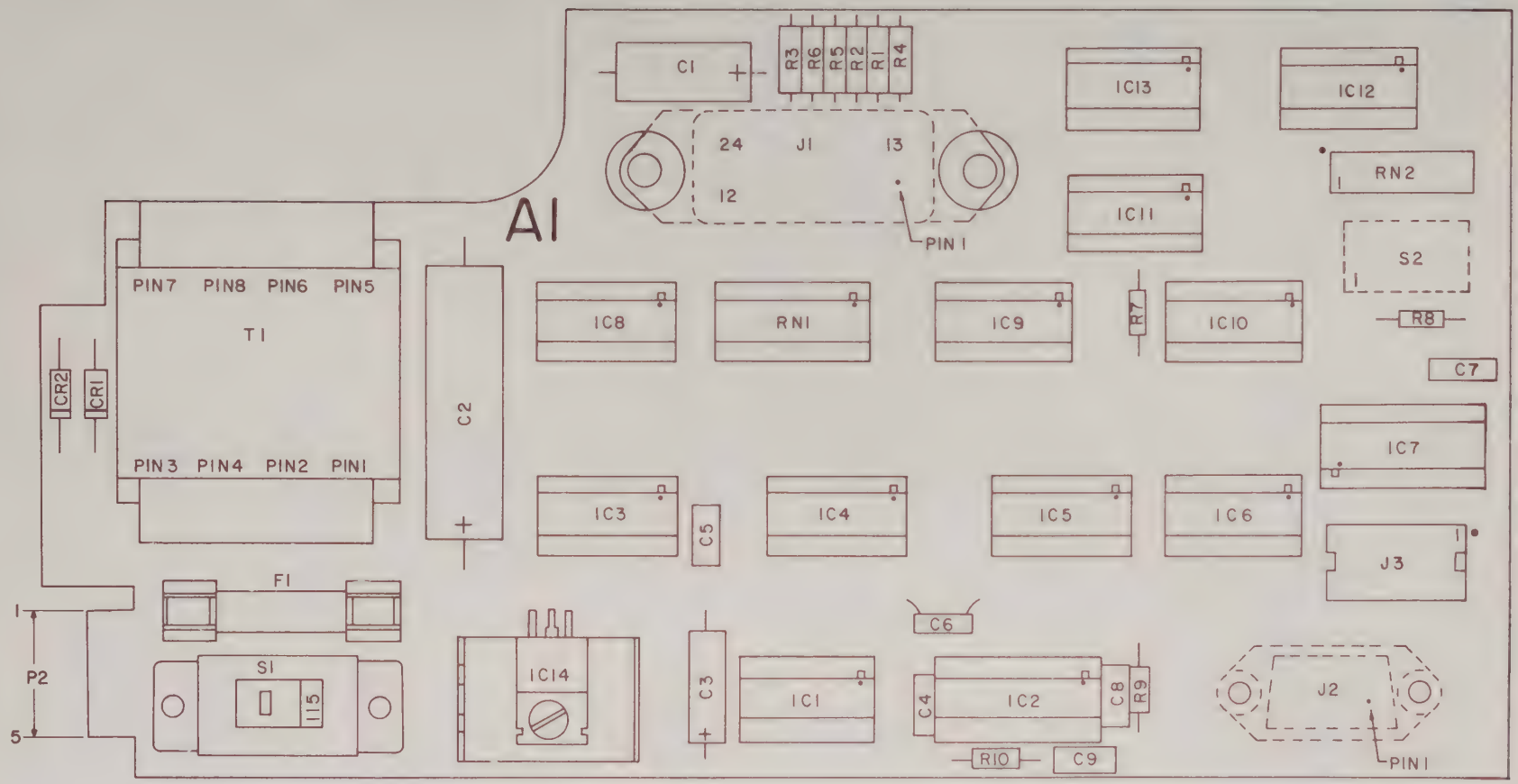


FIG. 5-5 COMPONENT LOCATION, MODEL SNR 488—4/8, INTERFACE CARD (A1).

KEPCO® REPLACEMENT PARTS LIST

MODEL SNR 488-4/8 CABINET ASSEMBLY (A2)

Code 09-0580

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
FRONT PANEL CONTAINS:					
SDS101	1	Switch/Pilot Light SPST-115/230V	Carling Switch LTA-201-PB-B-R	127-0322	1
CABINET CONTAINS:					
FOR SNR 488-4 ONLY:					
F201 (115V)	1	Fuse, Slow-Blow 115V, 0.6A	Buss Type MDL	141-0077	5
F201 (230V)	1	Fuse, Slow-Blow 230V, 0.3 A	Buss Type MDL	141-0023	5
FOR SNR 488-8 ONLY:					
F201 (115V)	1	Fuse, Slow-Blow 1A—250V	Buss Type MDL	141-0047	5
F201 (230V)	1	Fuse, Slow-Blow 0.5A—250V	Buss Type MDL	141-0036	5
MODEL SNR 488-4/8 MOTHER BOARD ASSEMBLY (A3)					
C301	1	Cap., Ceramic, Disc. 0.01uF, +80 -20%, 50V	Centralab Type CK-103	117-0860	1
C302	1	Cap., Tantalum, Ax. Leads 1uF, 20%, 50V	Sprague Type 162D	117-0815	1
C303,304, 305,306 307,308, 309,310	8	Cap., Ceramic, Disc. 0.001uF, +100 -20%, 1KV	Centralab Type DD-102G	117-0894	2
C311	1	Cap., Ceramic Disc 330pF, 5%, 1KV	Radio Mat. Corp. Type C-NPO	117-0556	1
IC301	1	I.C., Hex-Buffer 16 Pin Dip	Fairchild 74LS365	250-0072	1
RN301	1	Res., Network 3K ohm, 5%, (7 units) 1W total	Sprague Type 216	234-0001	1
R301,302, 303,304, 305,306 307,308	8	Res., Fxd, Molded 100 ohm, 10%, 1/4W	Ohmite EB1011	115-2231	2
R309,310	2	Res., Fxd, Molded 22K ohm, 10%, 1/4W	Ohmite EB2231	115-2458	1
R311	1	Res., Fxd, Molded 47K ohm, 10%, 1/4W	Ohmite EB4731	115-2237	1
CR301	1	Diode, Rect., Ax. Leads 100V PIV, 1A	Semicon Inc. Type SI-1	124-0133	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE. THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

KEPCO® REPLACEMENT PARTS LIST

MODEL SNR 488-4/8 INTERFACE CARD ASSEMBLY (A1)

Code 09-0580

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
C1	1	Cap., Elect., Rad. Leads 100uF, 20%, 6V	Sangamo Type 556	117-0487	1
C2	1	Cap., Elect., Ax. Leads 950 uF, +150 -10%, 15V	Sangamo Type 052	117-0821	1
C3	1	Cap., Elect., Can 22uF, 20%, 15V	General Electric Type 76F	117-0444	1
C4,5,6,7	4	Cap., Ceramic, Disc. 0.01uF, +80 -20%, 50V	Centralab Type CK-103	117-0860	1
C8,9	2	Cap., Ceramic, Disc. 330 pF, 5%, 1KV	Radio Material Corp. Type C-NPO	117-0556	1
CR1,2	2	Rect. Diode, Ax. Leads 100V PIV , 1A	Semicon Inc. Type SI-1	124-0133	1
F1 (115V)	1	Fuse, Slow-Blow 115V-1/16A	Buss Type MDL	141-0021	5
F1 (230V)	1	Fuse, Slow-Blow 230V-1/32A	Buss Type MDL	141-0019	5
IC1	1	I.C. Quad 2-input OR 14 pin-dual inline	Fairchild 74LS32	250-0069	1
IC2	1	I.C., Dual one-shot 16 pin-dual inline	Fairchild 96L02	250-0073	1
IC3	1	I.C., Dual J-K Flip-flop 14 pin-dual inline	Fairchild 74LS107	250-0059	1
IC4	1	I.C., Quad 2-input NAND 14 pin, dual inline	Fairchild 74LS00	250-0053	1
IC5	1	I.C., Triple 3-input NAND 14 pin, dual inline	Fairchild 74LS10	250-0070	1
IC6	1	I.C., Quad 2-input NAND Buffer, 14 pin, dual-inline	Texas Instr. 7438	250-0061	1
IC7	1	I.C., ROM (32x8) 256 bit 16 pin, dual inline	Kepco Inc. 250-0075	250-0075	1
IC8	1	I.C., Quad 2-input AND 14-pin, dual inline	Fairchild 74LS08	250-0055	1
IC9,13	2	I.C., Hex Inverter 14-pin, dual inline	Fairchild 74LS04	250-0054	1
IC10	1	I.C.,8-input NAND 14-pin, dual inline	Fairchild 74LS30	250-0057	1
IC11,12	2	I.C., Quad 2-input Ex Nor 14-pin, dual inline	Fairchild 74-LS266	250-0060	1
IC14	1	I.C., Voltage Regulator (+)5V, TO-220	Fairchild μA 78MOSC	250-0062	1
R1,2,3	3	Res., Fxd, Molded 6.2K ohm, 5%, 1/4W	TRW GBT-1/4	115-2694	1
R4,5,6, 7,8	5	Res., Fxd, Molded 3K ohm, 5%, 1/4W	TRW GBT-1/4	115-2693	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

KEPCO® REPLACEMENT PARTS LIST

MODEL SNR 488-4/8 **INTERFACE CARD ASSEMBLY (A1)** **Code 05-2981**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
R9,10	2	Res., Fixed Molded 24K ohm, 5%, ¼W	Allen Bradley Type CB	115-2699	1
RN1	1	Res., Network 3K ohm/6.2K ohm, 5% 14 pairs, 2W total	Sprague Type 216	234-0002	1
RN2	1	Res., Network 3K ohm, 5% (7 units) 1W total	Sprague Type 216	234-0001	1
S1	1	Switch, Slide, DPDT PCB Type	Switchcraft 46206LFH	127-0294	1
S2	1	Switch, Rocker, 6 pos.	Amp 435640-4	127-0329	1
T1	1	Transformer, Power Low Profile	Signal Transformer LP16-350	175-0438	1

MISCELLANEOUS MECHANICAL PARTS:

NA	2	Captive Panel Screw, 6-32 x$^{5}/_{8}$	108-0169
NA	2	Screw retainer for above	108-0167
FX201	1	Fuse Holder	150-0001
P201	1	Power Receptacle	143-0290
J1	1	Connector, Female Panel, 24 pin	143-0295
J2	1	Connector, Female, Panel 9 pin	143-0294
NA	1	Flat Cable	118-0558

5-17/5-18

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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KEPCO® REPLACEMENT PARTS LIST

MODEL SNR 488-4/8 INTERFACE CARD ASSEMBLY (A1) **Code 09-0580**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
C1	1	Cap., Elect., Rad. Leads 100uF, 20%, 6V	Sangamo Type 556	117-0487	1
C2	1	Cap., Elect., Ax. Leads 950 uF, +150 -10%, 15V	Sangamo Type 052	117-0821	1
C3	1	Cap., Elect., Can 22uF, 20%, 15V	General Electric Type 76F	117-0444	1
C4,5,6,7	4	Cap., Ceramic, Disc. 0.01uF, +80 -20%, 50V	Centralab Type CK-103	117-0860	1
C8,9	2	Cap., Ceramic, Disc. 330 pF, 5%, 1KV	Radio Material Corp. Type C-NPO	117-0556	1
CR1,2	2	Rect. Diode, Ax. Leads 100V PIV , 1A	Semicon Inc. Type SI-1	124-0133	1
F1 (115V)	1	Fuse, Slow-Blow 115V-1/16A	Buss Type MDL	141-0021	5
F1 (230V)	1	Fuse, Slow-Blow 230V-1/32A	Buss Type MDL	141-0019	5
IC1	1	I.C. Quad 2-input OR 14 pin-dual inline	Fairchild 74LS32	250-0069	1
IC2	1	I.C., Dual one-shot 16 pin-dual inline	Fairchild 96L02	250-0073	1
IC3	1	I.C., Dual J-K Flip-flop 14 pin-dual inline	Fairchild 74LS107	250-0059	1
IC4	1	I.C., Quad 2-input NAND 14 pin, dual inline	Fairchild 74LS00	250-0053	1
IC5	1	I.C., Triple 3-input NAND 14 pin, dual inline	Fairchild 74LS10	250-0070	1
IC6	1	I.C., Quad 2-input NAND Buffer, 14 pin, dual-inline	Texas Instr. 7438	250-0061	1
IC7	1	I.C., ROM (32x8) 256 bit 16 pin, dual inline	Kepco Inc. 250-0075	250-0075	1
IC8	1	I.C., Quad 2-input AND 14-pin, dual inline	Fairchild 74LS08	250-0055	1
IC9,13	2	I.C., Hex Inverter 14-pin, dual inline	Fairchild 74LS04	250-0054	1
IC10	1	I.C.,8-input NAND 14-pin, dual inline	Fairchild 74LS30	250-0057	1
IC11,12	2	I.C., Quad 2-input Ex Nor 14-pin, dual inline	Fairchild 74-LS266	250-0060	1
IC14	1	I.C., Voltage Regulator (+)5V, TO-220	Fairchild μA 78MOSC	250-0062	1
R1,2,3	3	Res., Fxd, Molded 6.2K ohm, 5%, 1/4W	TRW GBT-1/4	115-2694	1
R4,5,6, 7,8	5	Res., Fxd, Molded 3K ohm, 5%, 1/4W	TRW GBT-1/4	115-2693	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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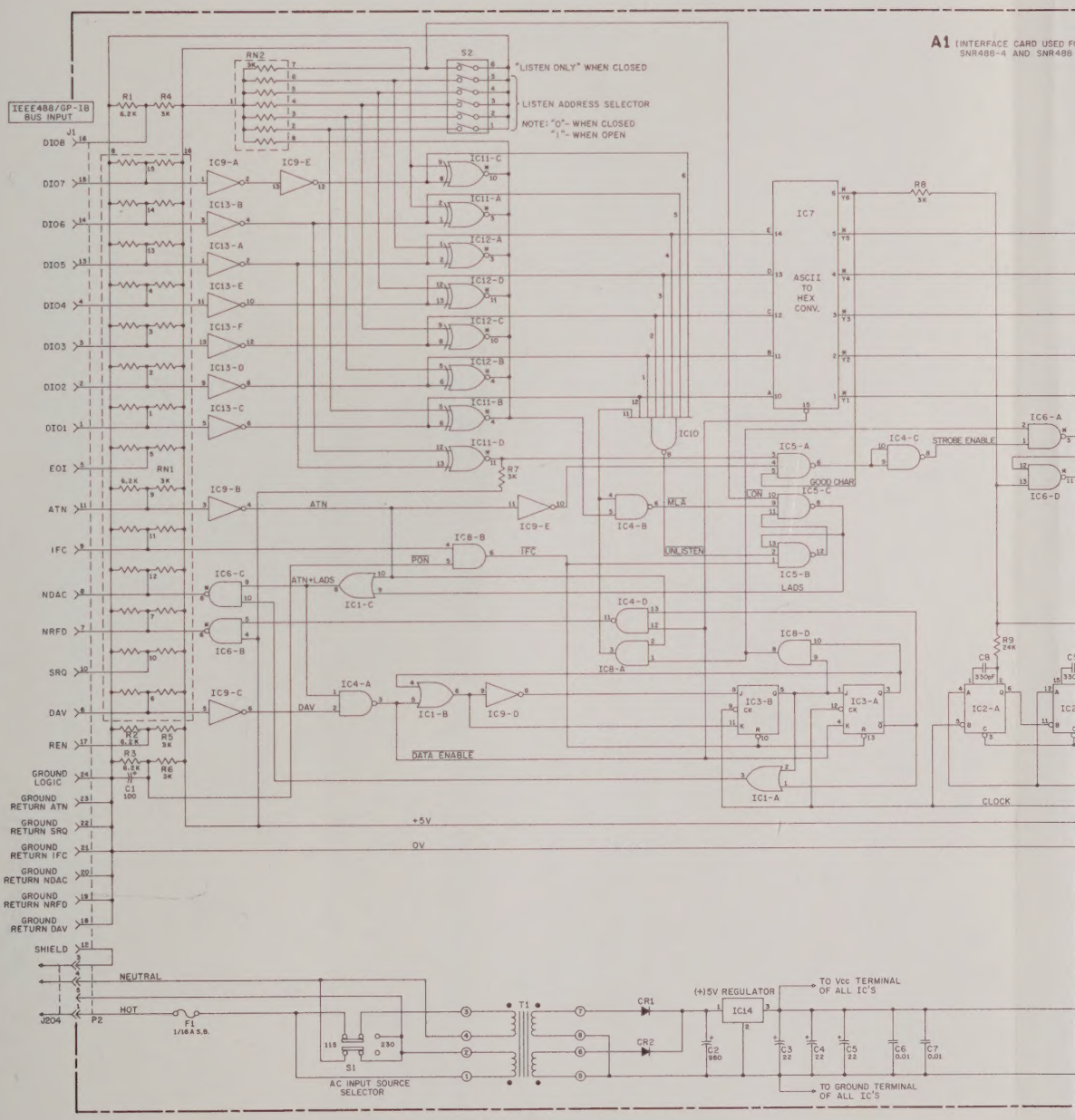

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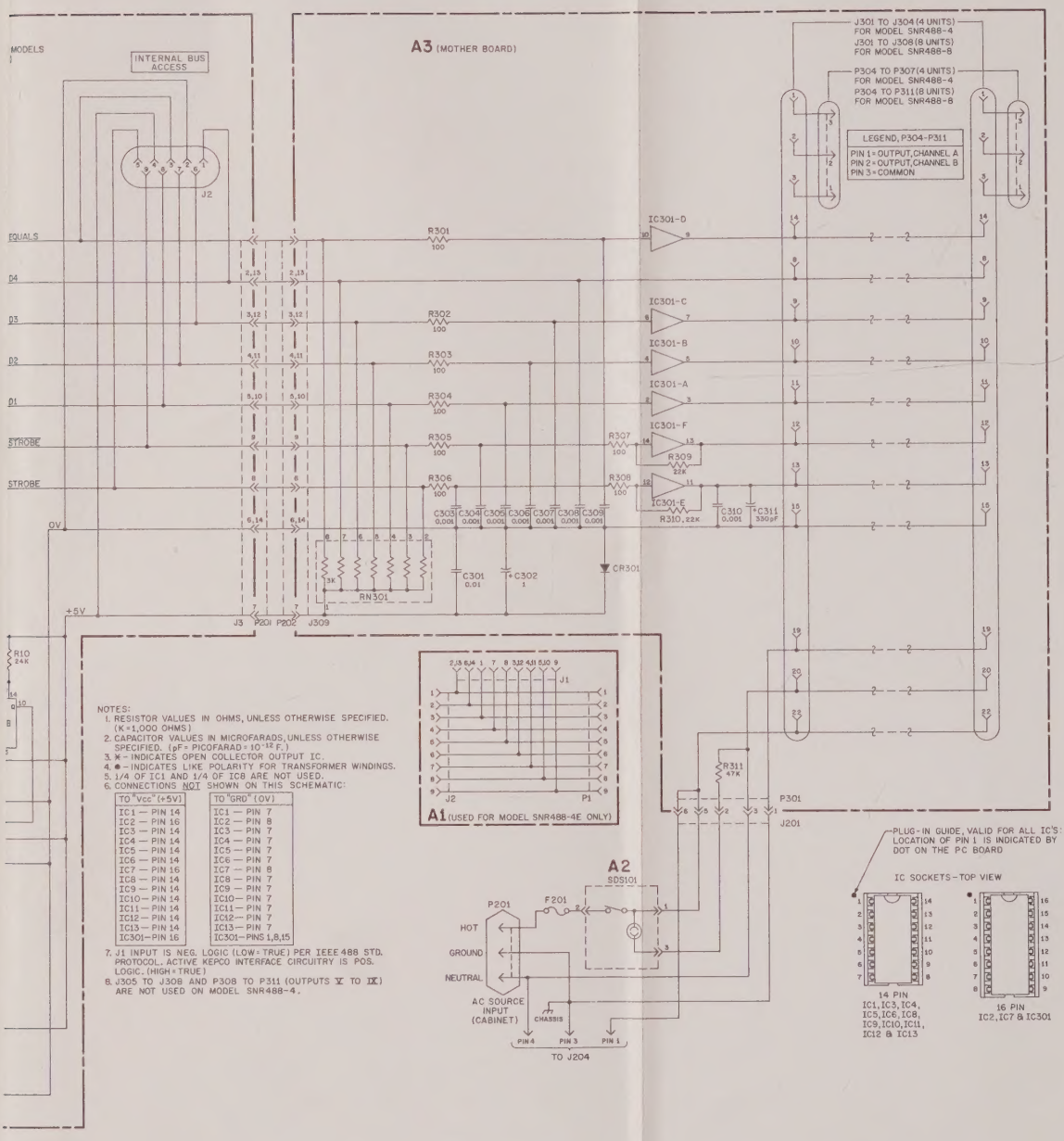
Data subject to change without notice.
PATENT NOTICE: Applicable Patent Numbers will be supplied on request.



NOTES:
1. RESISTOR VALUES IN OHMS, UNLESS OTHERWISE SPECIFIED. (K = 1,000 OHMS)
2. CAPACITOR VALUES IN MICROFARADS, UNLESS OTHERWISE SPECIFIED. (pF = PICOFARAD = 10^{-12} F.)
3. ✕ - INDICATES OPEN COLLECTOR OUTPUT IC.
4. ● - INDICATES LIKE POLARITY FOR TRANSFORMER WINDINGS.
5. 1/4 OF IC1 AND 1/4 OF IC8 ARE NOT USED.
6. CONNECTIONS NOT SHOWN ON THIS SCHEMATIC:

TO "Vcc" (+5V)	TO "GRD" (0V)
IC1 — PIN 14	IC1 — PIN 7
IC2 — PIN 16	IC2 — PIN 8
IC3 — PIN 14	IC3 — PIN 7
IC4 — PIN 14	IC4 — PIN 7
IC5 — PIN 14	IC5 — PIN 7
IC6 — PIN 14	IC6 — PIN 7
IC7 — PIN 16	IC7 — PIN 8
IC8 — PIN 14	IC8 — PIN 7
IC9 — PIN 14	IC9 — PIN 7
IC10 — PIN 14	IC10 — PIN 7
IC11 — PIN 14	IC11 — PIN 7
IC12 — PIN 14	IC12 — PIN 7
IC13 — PIN 14	IC13 — PIN 7
IC301 — PIN 16	IC301 — PINS 1, 8, 15

7. J1 INPUT IS NEG. LOGIC (LOW = TRUE) PER IEEE 488 STD. PROTOCOL. ACTIVE KEPCO INTERFACE CIRCUITRY IS POS. LOGIC. (HIGH = TRUE)
8. J305 TO J308 AND P308 TO P311 (OUTPUTS Ⅴ TO Ⅸ) ARE NOT USED ON MODEL SNR488-4.

FIG. 5-11 SCHEMATIC DIAGRAM, KEPCO MODELS SNR 488-4 AND SNR 488-8 RACK CABINET WITH MOTHERBOARD AND INTERFACE CARD.

KEPCO®

INSTRUCTION MANUAL CORRECTION

Please note the following corrections to the Manual Material as indicated:

PARTS LIST:

1) CHANGE: IC9,13 IC Hex-Inverter Kepco P/N 250-0054

TO: IC9,13 IC Schmitt Trigger Hex-Inverter Kepco P/N 250-0114

SNR 488-4/12-2881/r5 C4905

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